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# SCIENCE

30 August 1957

Volume 126, Number 3270

6 AUG 4 - 1957
Cont. Copy

**Editorial**

To and Fro ..... 379

**Articles**

The "Clock Paradox" and Space Travel: *E. M. McMillan* ..... 381

Image of the Scientist among High-School Students: *M. Mead* and *R. Métraux* ..... 384

A. S. King, Spectroscopist: *H. D. Babcock* ..... 390

**News of Science**

News Articles and Briefs; Scientists in the News; Recent Deaths ..... 391

**Reports**

End Groups of Oxidized Rubber: *E. M. Bevilacqua* ..... 396

Inhibition of Cell Division of *Escherichia coli* by Low Doses of Ultraviolet Light: *R. A. Deering* and *R. B. Setlow* ..... 397

Respiratory Competence in the Diagnosis of Gene-Controlled Phenotypes in Saccharomyces: *C. C. Lindegren* et al. ..... 398

"Lethal" Variant of *Candida albicans*, a "Petite Colonie" Mutant: *A. Alvarez* and *J. E. Mackinnon* ..... 399

O-Methylation of Epinephrine and Other Catechols *in vitro* and *in vivo*: *J. Axelrod* ..... 400

Isolation of Cytopathogenic Viral Agent from Feces of Cattle: *T. Moll* and *A. V. Finlayson* ..... 401

Decomposition of Actinomycin by a Soil Organism: *E. Katz* and *P. Pienta* .. 402

Depths of Leaching in Glacial Deposits: *A. Dreimanis* ..... 403

Infantile Experience and Resistance to Physiological Stress: *S. Levine* ..... 405

Inapparent Lymphocytic Choriomeningitis Infection in Folic Acid-Deficient Mice: *V. H. Haas, G. M. Briggs, S. E. Stewart* ..... 405

**Book Reviews**

*The American Oasis; Methods of Biochemical Analysis; The Scientific Thought of Henry Adams; Handbuch der Physik; Chemical Engineering Practice; The People of Puerto Rico; Marine Algae of the Northeastern Coast of North America; Vergleichende Physiologie; Matrix Calculus; Nuclear Power Engineering*; Books Reviewed in *The Scientific Monthly*, September; New Books; Miscellaneous Publications ..... 407

**Meetings and Societies**

Archeologic Identification; Meeting Notes; Society Elections; Forthcoming Events ..... 412

Equipment News ..... 418

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## To and Fro

The international exchange of people, knowledge, and technical skills has probably never been more extensive than it is now. Americans, under the auspices of the international exchange program of the State Department, have taken part in a wide range of activities abroad. Some of our cultural exports under this program in recent years have been as follows: Dizzy Gillespie, *Porgy and Bess, Oklahoma,* symphony orchestras, weightlifters, trackmen, basketball players, engineers, scientists, agricultural experts, technicians, teachers, and students.

For the most part, exchange has been a two-way street. From abroad, with State Department aid, foreign legislators, legal experts, public administrators, lecturers, teachers, scientists, and engineers have come to this country. In addition, to mention only a single example, American methods of handling the news have been learned by foreigners through on-the-job training at our newspapers and television stations.

The extent of exchange in education may be appreciated by a glance at the figures compiled recently by the Institute of International Education for the year 1956–57. During that year 40,666 foreign students, 1153 foreign teachers and research workers, and 6741 foreign physicians were in the U.S. At the same time 1492 faculty members from U.S. institutions were abroad. The figures for American students abroad during that year are not yet available, but for 1955–56 they numbered 9887.

These are impressive figures, and so are the figures for geographic distribution. The foreign students, for example, came from more than 100 countries; American students went to 54 countries. The countries in which American students were not to be found and from which few or no students came to America were in the Soviet bloc.

Thus, the exchange is not as free as it might be. Despite the statements of high officials in both the Soviet and the U.S. Government about the desirability of promoting cultural exchange, very little has happened. True, there have been some exchanges of agriculturalists, engineers, and scientists. But these people came to the U.S. as Soviet officials and thus were able to sidestep the U.S. requirement that nonimmigrant aliens must be fingerprinted. The fingerprinting requirement has blocked attempts to negotiate an agreement for a more general exchange of people between the U.S. and the Soviet Union. Neither students nor ballerinas can pass as government officials.

In an attempt to break the impasse, Senator Javits and Representative Carnahan have introduced identical legislation in the Senate and the House. The bills propose that the State Department negotiate agreements for reciprocal exchange with the Soviet Union and that the Secretary of State and the Attorney General be authorized to waive the fingerprinting requirement. These legislators join the State Department in having no fear that waiving the requirement would jeopardize our security; nor does the President, who said last January that the requirement lacks "any significant contribution to our national security."

If the Soviet objection to fingerprinting is only a pretense, passage of these bills would make it apparent. But it is not the main point of the legislation to test this objection. The main point is to try to find some way to promote a freer exchange in the belief that this would lessen the tensions and thus improve the chances for peace. It is worth a try.—G. DUS.

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# The "Clock Paradox" and Space Travel

Edwin M. McMillan

In the pages of *Nature* there have appeared recently exchanges of correspondence between McCrea (*1*), Dingle (*2*), and Crawford (*3*). Dingle maintains that there will be no difference in age between a returned space traveler and his twin brother who stays home, while the other authors maintain that such a difference will exist, in just the amount computed by a straightforward application of the Lorentz transformation of special relativity. Dingle's argument is based on an old difficulty known as the "clock paradox," which stems from an apparent ambiguity in the answer to the question: If all motion is relative, how does one decide who traveled and who stayed home?

McCrea and Crawford have in my opinion clearly won the argument, and perhaps further remarks are superfluous. However, because of the considerable interest aroused, it may be worth while to restate the situation in new words and all in one place; hence this article. It has three sections. In the first, the "paradox" is stated and resolved, using only inertial coordinate systems; in the second, a treatment of accelerated coordinate systems based on the principles of special relativity is given; in the third, the possibility of practical implications for space travel is examined.

## The "Paradox" and Its Resolution

The apparent difficulty in the "paradox" can be stated very simply. The twin brothers $B$ and $B'$ are in relative motion with the velocity $v$. If $B$ considers himself at rest, he concludes from the usual formula for the time dilatation that the watch carried by $B'$ will register a time interval

$$\sqrt{1-(v^2/c^2)}\,\Delta t$$

while his own watch registers a time interval $\Delta t$. If $B'$ makes a journey at velocity $v$ and returns home at the same velocity, his elapsed time (as measured by his watch or by his own physiological aging) will be smaller by the factor

$$\sqrt{1-(v^2/c^2)}$$

than the elapsed time experienced by $B$, who stayed home. However, if "all motion is relative," $B$ can just as well say that he went on the trip while $B'$ stayed at rest, and he can state that he is the one that should be younger. If both statements were correctly derived from the principles of special relativity, there would indeed be a paradox and one would conclude that the theory is not self-consistent and must be rejected. What we shall show is that the first statement is correct while the second is wrong; there is no true paradox, and the result that travelers live longer than stay-at-homes, while sometimes called "paradoxical," is really in the "strange but true" category.

To examine this matter more closely, we must set up the situation in greater detail. Suppose that $B$ is at rest at the origin of an intertial coordinate system $S$, while $B'$ has the same relation to an inertial coordinate system $S'$, and that the two coordinate systems are in relative motion with a velocity $v$. Suppose also that the watches of the two brothers are set so that they each read zero when the two origins coincide, which defines the starting point of the trip. The coordinates and times in the two systems are then related by the Lorentz transformation

$$x' = \gamma(x - vt) \tag{1}$$

$$t' = \gamma\left(t - \frac{v}{c^2}x\right) \tag{2}$$

$$\gamma = 1/\sqrt{1-(v^2/c^2)}$$

From these equations, and from the fact that the brothers are located at their respective origins, we find for the relation between times observed at the location of $B$ (where $x = 0$)

$$t' = \gamma t \tag{3}$$

while at the location of $B'$ (where $x' = 0$), we find

$$t = \gamma t' \tag{4}$$

The quantities in these equations are clock readings $t$ at coordinates $x$ in $S$, and $t'$ and $x'$ similarly defined in $S'$, while the equations give the relations between these quantities at localized events which are perceived in both systems. We may picture each system as carrying a long line of measuring rods and clocks, with observers to note down the clock reading and distance coordinate whenever an event occurs. These of course do not actually exist, but we are allowed to use them in discussion since the Lorentz transformation is constructed in such a way that all relations between events (such as the sending and reception of light signals) perceived where there are actual observers are consistent with observations that might be made elsewhere.

Now imagine a very simple event in which $B'$ merely looks at his watch, notes that it has the reading $\tau$, and also observes the reading of the particular clock in $S$ that coincided with his location at that instant, obtaining for that the value $\gamma\tau$, as given by Eq. 4. This event alone is not sufficient to determine the relative elapsed time as seen by $B$ and $B'$; it must be correlated with another event, which is a watch reading made "simultaneously" by $B$.

Here we run into trouble in the interpretation of the word *simultaneous*. First consider the situation from the standpoint of $B$. One of his corps of observers reports (at any time after the event) that he saw $B'$ read his watch when he went by, and reports his readings of $t$ and $t'$, which are the same as those noted by $B'$

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at the same time and place. $B$ can then say: "When $B'$ looked at his watch, he saw the reading $\tau$; my own observer read the time as $\gamma\tau$ on his local clock; that clock is synchronized with my own watch; therefore, if I had looked at my watch when it indicated the time $\gamma\tau$, that event would have been simultaneous with the event consisting of $B'$ looking at his watch." Second, consider the situation from the standpoint of $B'$. He says to his observers: "One of you was next to $B$ when your clock read $\tau$, which is the time when I read my watch. What did you see on the watch of $B$?" The result, from Eq. 3, would be $\tau/\gamma$. Therefore, if $B$ had looked at his watch when it read $\tau/\gamma$, $B'$ would have considered that event to be simultaneous with his own watch-looking event.

Thus, to one event at $B'$, there correspond two different "simultaneous" events at $B$, depending on whose idea of simultaneity is accepted. This result is well known, and is not considered troublesome so long as $B$ and $B'$ are in relative motion at a distance apart; because of the symmetry of the situation, there is no way to decide who is "right," and there is no meaning in such a decision.

The usual next step is to have one of the observers reverse his motion, so that ages can be compared directly when the two come together again. However, the argument is just as cogent if we have them come to a state of relative rest, where age comparisons are meaningful even at a distance, and this approach is used because of its simplicity. The end of the trip will be defined by having one of the observers (say $B'$) come to rest relative to the other.

Now an element of dissymmetry is introduced, since $B'$ is the one who has to push the firing button of his decelerating rocket and whose accelerometer will deflect, while nothing will happen to $B$. This fact is used in a way which does not involve any arguments from general relativity (except insofar as it may give meaning to the concept of an inertial system) or any discussion of accelerated coordinate systems. The important thing is that, once $B'$ has stopped, he has dissociated himself from $S'$ and attached himself to $S$ (with a shift in the zero point of his time scale, of course); the system $S'$ remains unchanged. (We may note here that a reversal, rather than a stopping, of $B'$ can be treated by having him transfer to a third inertial system $S''$ moving in the opposite direction; this more complicated procedure leads to a result for the round trip consistent with what we get for the outward part.) It is also postulated, as is usually done and as seems physically reasonable, that acceleration as such does not change his clock reading. His readings of $\tau$ on his own watch and $\gamma\tau$ on the clock in $S$ at which he stopped are, one may say, transferred bodily into $S$, and he and $B$ can then compare notes with no ambiguity since they are at relative rest and since both use the same definition of simultaneity. Both $B$ and $B'$ agree that the ratio of elapsed times during the trip is that given by Eq. 4, and there is no "paradox."

Looking at the situation from another standpoint, one might inquire about the interpretation of a signal sent out by $B'$ at such a time that its arrival at $B$ is simultaneous (in $S'$) with the stopping of $B'$. Such a signal, seen by $B$ and interpreted as indicating "the end of the trip," would lead to a wrong result (to the usual "paradox" in fact). However, if $B$ is more careful, he will realize the discrepancy in concepts of simultaneity and correct for it. From Eq. 2 we find that the difference in $t$ between two events occurring at the same value of $t'$ and at locations a distance $\Delta x$ apart (in $S$) is equal to $v\Delta x/c^2$. The distance $\Delta x$ in the case being considered is $v\gamma\tau$, the length of the journey in $S$; the events are the arrival of the signal at $B$ and the stopping of $B'$. The time correction $v\Delta x/c^2$ has the value $(v^2/c^2)\ \gamma\tau$, or $[\gamma - (1/\gamma)]\tau$. When this is added to $\tau/\gamma$, the observed value of $t$ at the arrival of the signal, the value $t = \gamma\tau$ for the time of stopping of $B'$ is obtained, in agreement with what was seen directly by observers in $S$. What will $B'$ think of this? He sent the signal with the expectation that it would reach $B$ when he reached the end of his journey, but when he gets into communication with the observers in $S$ after the trip is over, they tell him that the signal arrived before he stopped. He resolves this apparent dilemma by realizing that when he jumped from $S'$ into $S$ he had to replace the concept of simultaneity in $S'$ by that of simultaneity in $S$, the difference introduced thereby being equal to the "time correction" already defined.

At the cost of some repetition, we return to the question: How does one distinguish the stopping of $B'$ from the starting of $B$, when the change in relative velocity is the same in both cases? Physically, the acceleration is felt by $B'$ and not by $B$; mathematically, the acceleration is treated as a transfer from one inertial system to another, and here again the distinction is just as apparent. The essential symmetry of the treatment is clear if one notes that the concept of simultaneity is used in that inertial system in which *both* of the brothers are initially and finally at rest.

By a simple but interesting transformation, it is possible to relate the age difference of the brothers to their *changes* in velocity. For symmetry, allow both brothers to move, with velocities corresponding to $\gamma_1$ and $\gamma_2$. Then the difference between their elapsed times $t_1'$ and $t_2'$ is given by

$$t_1' - t_2' = \int[(1/\gamma_1) - (1/\gamma_2)]\,dt = [(1/\gamma_1) - (1/\gamma_2)]t - \int t\,d[(1/\gamma_1) - (1/\gamma_2)]$$

Since we have postulated that $\gamma_1 = \gamma_2 = 1$ (that is, both brothers are at rest in the system in which $t$ is measured) at the start and finish, the first term on the right vanishes. If the velocity changes are thought of as discontinuous (being expressed as changes in $1/\gamma$), the second term becomes a sum, giving:

$$t_1' - t_2' = \Sigma t\Delta(1/\gamma_2) - \Sigma t\Delta(1/\gamma_1)$$

This illustrates both the symmetry of the treatment and the importance of changes in velocity. Note that only the magnitudes of the velocities enter, and that the motion need not be confined to the $x$-axis.

## Accelerated Coordinate Systems

It is of some interest, although not necessary for this problem, to inquire what happens in an accelerated coordinate system. In the treatment given in the preceding section, the system $S'$ was not accelerated, but the traveler simply left it, like a man jumping off a train. Now we suppose that the train slows down with the man on it. The coordinate system (that is, the train, or a line of space ships if you prefer) carries measuring rods and clocks by which times and distances are measured. It is accelerated by applying power to the wheels or firing rockets at times considered simultaneous in itself. We start again with Eqs. 1 and 2 and suppose that the acceleration occurs suddenly at $t' = 0$. We now stand in $S$ and watch the process. We note that the acceleration does not now seem to be simultaneous; Eq. 2 shows that, at each $t$, it occurs at an $x$ given by $x = (c^2/v)t$. Thus the acceleration looks like a wave traveling with the velocity $c^2/v$. (The fact that this velocity is greater than $c$ is not objectionable since the wave does not convey a signal.)

An acceleration wave in the form of a step of finite amplitude will not retain its shape since the wave velocity varies with $v$; therefore we deal at first with a step wave of infinitesimal amplitude $dv$. The new Lorentz transformation after the wave has passed is

$$x' = (\gamma + d\gamma)[x - (v + dv)t] \qquad (5)$$

$$t' = (\gamma + d\gamma)\left[t - \frac{v + dv}{c^2}x\right] \qquad (6)$$

where $t'$ retains its meaning as a time considered simultaneous in the new $S'$. However, it no longer corresponds to the clock readings in the new $S'$ except at

$x' = 0$. To see this, we note that a clock at a given $x'$ does not change its reading suddenly when the acceleration occurs, while $t'$ does make a sudden change. The latter is computed by subtracting Eq. 2 from Eq. 6, evaluated at the appropriate place and time in $S$—that is, at $x = (c^2/v)t$, with the result that $t'$ at a given point changes suddenly by the amount

$$dt' = -\gamma x dv/c^2 = -\gamma^2 x' dv/c^2$$

The clock reading at $x'$, which we shall call $T'$, does not suffer a corresponding instantaneous change, so that a difference between $T'$ and $t'$ appears:

$$d(T' - t') = \gamma^2 \frac{x' dv}{c^2} \qquad (7)$$

A similar treatment applied to Eqs. 1 and 5 shows that the change in $x'$ at a given point (say a given scale division on an actual measuring rod in $S'$) is equal to zero. This is not trivial; $x'$ is not defined as a scale reading but as a coordinate in terms of which the Lorentz transformation is valid; scale readings, like clock readings, cannot change suddenly, but their interpretation as coordinates can. For example, suppose that an acceleration were made to take place as a wave traveling with a velocity (in $S$) other than $c^2/v$. Then there would be a change in $x'$ at a fixed scale reading in $S'$. The observer in $S'$ would interpret this as an actual physical expansion or compression of his system arising from the fact that the acceleration no longer occurs simultaneously at all points in his system. In other words, the specification that the acceleration be simultaneous according to $t'$ is necessary if we require that no "strains" be introduced into $S'$.

The concept of an acceleration wave with velocity $c^2/v$ in $S$ gives a simple pictorial representation of the generation of a Lorentz contraction with no discontinuous coordinate changes. Consider a measuring rod in $S'$ with an apparent length $l$ in $S$. The time interval in $S$ for the wave to pass the length of the rod is $l/[(c^2/v) - v]$. During this interval, one end is moving faster than the other by the amount $dv$, and the apparent final change in length is

$$-l dv/[(c^2/v) - v] = -\gamma^2 l v dv/c^2$$

According to the Lorentz contraction $l = l'/\gamma$. Differentiating this, we find that

$$dl = -\gamma l' v dv/c^2 = -\gamma^2 l v dv/c^2$$

in agreement with the result obtained from the wave picture.

It is now of interest to find out whether Eq. 7 is consistent with general relativity, which says that two clocks, at a distance $x'$ apart in a system suffering acceleration $a'$, will appear to differ in rate by the amount $a'x'/c^2$, and therefore will acquire a difference in reading $x'du/c^2$ if the acceleration continues just long enough to produce a velocity change $du'$. The velocity change $du'$ is a small increment of velocity from rest, as seen by the observer in the accelerated system; to find the corresponding change in the velocity $v$ as seen by an outside observer, we differentiate the relativistic formula for the composition of velocities, with the result that $dv = (1/\gamma^2)\, du'$. The change in clock readings, expressed in terms of $dv$, is therefore in agreement with Eq. 7, and we have derived the change in clock rates in an accelerated system using special relativity alone. The generalization to a gravitational field requires, of course, the use of the equivalence principle of general relativity.

Now we wish to consider the effect of a finite change in $v$, which can be thought of as taking place by means of a set of superimposed infinitesimal stepwise acceleration waves. The resulting composite wave can be stepwise at only one point because the wave velocity varies with $v$. In the case of a stepwise increase in $v$ (assumed to be initially positive) at $x = 0$ and $t = 0$, the wave will spread out in the forward direction as $t$ increases, and cannot be defined for $x < 0$, $t < 0$. In the case of a decrease in $v$ at the same place and time, the wave is spread out behind at earlier times, and cannot be defined for $x > 0$, $t > 0$. In order to generate such a wave, the firing of the rockets in the line of space ships defining $S'$ must be scheduled differently at different points; if the acceleration is instantaneous at one point, it must be spread out, according to local clock readings, and the rate of acceleration must be correspondingly reduced, at other points. This corresponds to the fact that each velocity increment must occur simultaneously in $t'$, while the clocks do not continue to indicate $t'$.

After the complete acceleration wave has passed, the total change in clock readings is obtained by integrating Eq. 7. If the relative velocity changes, for instance, from 0 to $v$, we find

$$T' - t' = \int_0^v \gamma^2 \frac{x'}{c^2}\, dv = \frac{x'}{c} \tanh^{-1}\left(\frac{v}{c}\right) \qquad (8)$$

This is not to be confused with the "time correction" used earlier, which has the same value only when $v \ll c$. The "time correction" is the result of a discrepancy in the estimation of simultaneity in *two different coordinate systems* with relative motion; Eq. 8 represents a desynchronization of clocks *in the same coordinate system*.

Finally, we inquire what relation this has to the "paradox." When $B'$ stops, suppose that he brings his whole coordinate system to rest with him, and then compares the clock in his system at the location of $B$ with the watch of $B$. This clock is out of synchronization with his own by the amount shown by Eq. 8, but he is presumed to be clever enough to know this (or to find it out by measurement after he has stopped), so he corrects for it, and the actual value of Eq. 8 does not enter into the result. He might just as well have used the already existing system $S$, in which he is at rest after stopping, and simply taken the reading of the clock opposite which he stopped to be elapsed time as estimated by $B$, which leads to the same result and is equivalent to the choice of Eq. 4 for the relation between the elapsed times.

## Implications for Space Travel

The great recent interest in the "clock paradox" is based on its possible consequences for travelers in space; this transcends in popular appeal the more basic matters of principle involved. Therefore let us look at it from that standpoint. First, could an acceleration tolerable to human beings, acting for a reasonable time, produce velocities great enough to give an appreciable time dilatation? To answer this, we must find the distance $x$ (in the rest system of the starting point) traveled in time $t'$ (in the traveler's rest system) while the traveler feels the constant acceleration $a'$. We first find the velocity $v$ by integrating the relation $dv = (1/\gamma^2)\, du'$ (introduced in the preceding section), noting that $du'/dt' = a'$, with the result

$$v/c = \tanh \frac{a'}{c} t'$$

Then

$$x = \int_0^t v dt = \int_0^{t'} \gamma v dt' = \frac{c^2}{a'}\left(\cosh \frac{a'}{c} t' - 1\right)$$

If $x$ is measured in light years, $t'$ in years, and $a'$ in units equal to the normal gravitational acceleration at the surface of the earth, then

$$x = \frac{0.97}{a'}\left(\cosh \frac{a'}{0.97} t' - 1\right)$$

This is a remarkable result. For example, a man traveling for 21 years under a constant acceleration of 1 g would go a distance of $1.2 \times 10^9$ light years! If he then reversed his acceleration, he would finally come to rest at a point $2.4 \times 10^9$ light years distant from his starting place, having spent 42 years of his life on the trip. The results are less dramatic for shorter trips; even for rather high accelerations (on a human

scale), the relativistic time modifications are negligible for travel within the solar system. For example, a man going to Neptune and stopping there, at an acceleration of 10 $g$, would spend 5 days on the trip but would gain only 1.5 minutes of time.

Then there is the question of the energy involved. The man who travels for 21 years at 1 $g$ reaches a value of $\gamma$ equal to $1.2 \times 10^9$, at which point his kinetic energy is utterly fantastic. If his vehicle weighs (at rest) 1 ton, then its energy content is equal, in round numbers, to the energy released in the annihilation of $10^9$ tons of matter, or in the fission of $10^{12}$ tons of uranium; it would be sufficient to melt the entire crust of the earth to a depth of about 30 miles. The man who makes the more modest trip to Neptune at 10 $g$ reaches $\gamma = 1.0025$, and the kinetic energy of his 1-ton ship ($2 \times 10^{17}$ joules) corresponds to that released in the fission of about 2 tons of uranium; because of the limited efficiency of rocket propulsion, the actual energy needed would be much greater. The use of such energy quantities in a rocket ship is so far beyond any foreseeable practical limits, and the time gain in that case is so small, that it is hard to picture a practical case of space travel in which the time dilatation can be considered important. This conclusion, of course, does not detract from the interest of the fundamental principles involved in the "clock paradox" (*4*).


**References and Notes**

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2. H. Dingle, *Nature*, **177**, 782, 785 (1956); **178**, 680 (1956); **179**, 865, 1242 (1957).
3. F. S. Crawford, Jr., *Nature* **179**, 35, 1071 (1957).


4. I would like to express my appreciation to Frank S. Crawford, Jr., David L. Judd, W. K. H. Panofsky, Henry P. Stapp, and Edward Teller for many useful discussions. Since I have not read widely in the literature of this subject, I apologize to any authors who may have already published any of the material given.


# Image of the Scientist among High-School Students

## A Pilot Study


Margaret Mead and Rhoda Métraux


This study is based on an analysis of a nation-wide sample of essays written by high-school students in response to uncompleted questions. The following explanation was read to all students by each administrator. "The American Association for the Advancement of Science (*1*), a national organization of scientists having over 50,000 members, is interested in finding out confidentially what you think about science and scientists. Therefore, you are asked to write in your own words a statement which tells what you think. What you write is confidential. You are not to sign your name to it. When you have written your statement you are to seal it in an envelope and write the name of school on the envelope. This is not a test in which any one of you will be compared with any other student, either at this school, or at another school. Students at more than 120 schools in the United States are also completing the statement and your answer and theirs will be considered together to really find out what all high-school students think as a group of people."

In general, the study shows that, while an official image of the scientist—that is, an image that is the correct answer to give when the student is asked to speak without personal career involvement—has been built up which is very positive, this is not so when the student's personal choices are involved. Science in general is represented as a good thing: without science we would still be living in caves; science is responsible for progress, is necessary for the defense of the country, is responsible for preserving more lives and for improving the health and comfort of the population. However, when the question becomes one of personal contact with science, as a career choice or involving the choice of a husband, the image is overwhelmingly negative.

This is not a study of what proportion of high-school students are choosing, or will eventually choose, a scientific career. It is a study of the state of mind of the students among whom the occasional future scientist must go to school and of the atmosphere within which the science teacher must teach. It gives us a basis for reexamining the way in which science and the life of the scientist are being presented in the United States today.

### Objectives

Our specific objectives in this study were to learn the following.

1) When American secondary-school students are asked to discuss scientists in general, without specific reference to their own career choices or, among girls, to the career choices of their future husbands, what comes to their minds and how are their ideas expressed in images?

2) When American secondary-school students are asked to think of themselves as becoming scientists (boys and girls) or as married to a scientist (girls), what comes to their minds and how are their ideas expressed in images?

3) When the scientist is considered as a general figure and/or as someone the respondent (that is, the student writer) might like to be (or to marry), or, alternatively, might not like to be (or to marry), how do (i) the postive responses (that is, items or phrases, not answers) cluster, and (ii) the negative responses (that is, items or phrases) cluster?

4) When clusters of positive responses and clusters of negative responses are compared and analyzed, in what respects are the two types of clusters of responses (i) clearly distinguishable, and (ii) overlapping?

5) Is a generally positive attitude to the idea of science, an attitude which we


There is a great disparity between the large amount of effort and money being devoted to interesting young people in careers as scientists or engineers and the small amount of information we have on the attitudes those young people hold toward science and scientists. The Board of Directors of the AAAS has on several occasions discussed this disparity and the desirability of learning more about what high-school students actually think of science and scientists. This paper is one result of those discussions. Hilary Deason, director of the association's Traveling High-School Science Library Program, made all of the arrangements with the high schools and supervised the collection of the students' essays. The analysis of those essays and the preparation of this report were the responsibility of the two authors, Margaret Mead and Rhoda Métraux. Dr. Mead is associate curator of anthropology, American Museum of Natural History, New York, and Dr. Métraux is a research fellow at Cornell Medical College, New York.

are spending a great deal of money and effort to create, any guarantee of a positive attitude to the idea of science as a career?

### Selection of Respondents

Two separate samples of respondents were used in the study: sample A, a nation-wide sample of high schools, and sample B, a sample of high schools with widely different economic and educational characteristics.

Sample A consisted of 132 public high schools (including one junior high school) that were selected from schools associated with the Traveling High-School Science Library Program sponsored by the National Science Foundation and administered by the American Association for the Advancement of Science. Of these, 118 were drawn from the high schools that participated in this program and an additional 14 from schools that qualified for the program but could not be included in it.

Sample B consisted of 13 special schools: four parochial schools, eight preparatory schools, and one public science high school. All these were from the eastern seaboard, selected to provide contrasts in educational and economic level to the smaller public high schools in the nation-wide sample (sample A). Sample B was collected after the homogeneity of the nation-wide sample had been ascertained.

The total enrollment of the schools participating in the study was 48,000. Schools with an enrollment of less than 300 students were asked to have each student complete one form; schools with an enrollment of more than 300 students were asked to complete 300 forms. The total sample (sample A and sample B) is drawn from the essays written by approximately 35,000 students, and the essays were kept together by the class, grade, and school from which the essays came.

The sample was randomized by drawing envelopes of these replies in groups that included three schools in one state, or three tenth grades, or all the separate classes in three schools, so that no essay was ever separated from the context in which it had been written.

### Data-Gathering Instruments

We asked each high-school student respondent to write a brief essay on a topic set by an incomplete sentence which was printed at the top of a page, on which provision was also made for giving the school, the grade, the class or section, the age and sex of the respondent.

Three different forms were constructed, each with a different incomplete sentence. Each of these three sentences was chosen to elicit one major aspect of the image of the scientist.

Only one form was used in any one school (*2*), but the forms were so distributed that each form was used by at least one school in each state. These three forms are as follows.

Form I

Complete the following statement in your own words. Write at least a full paragraph, but do not write more than a page.

*When I think about a scientist, I think of*

Form II

If you are a *boy,* complete the following statement in your own words.

*If I were going to be a scientist, I should like to be the kind of scientist who*

If you are a *girl,* you may complete either the sentence above or this one.

*If I were going to marry a scientist, I should like to marry the kind of scientist who*

Form III

If you are a *boy,* complete the following statement in your own words.

*If I were going to be a scientist, I would* not *like to be the kind of scientist who*

If you are a *girl,* you may complete either the sentence above or this one.

*If I were going to marry a scientist, I would* not *like to marry the kind of scientist who*

Use of the three forms made it possible to distinguish between answers giving official versions of the image of the scientist and those involving the respondents personally, and the use of two forms of the personal question provided material on the links between negative and positive images, since many answers included responses relevant to both. Experience has shown that the way in which a question is phrased—that is, with a positive or with a negative emphasis—affects the phrasing of the answers by the respondents.

### Analysis of Material and Problems of Validation

This study is based on qualitative data. The material reflects the way individuals feel and think about a subject as well as whether they will answer questions about the subject in the affirmative or the negative. The use of quantitative data, gathered primarily to count the number of individuals in any given group who will respond in one way or in another, is the more desirable technique when one is interested in whether individuals will agree or disagree with some stated opinion rather than how they feel or why they feel as they do. The check marks or brief responses gathered by quantitative studies are generally too sparse in the expression of feeling and imagery to permit the definition, or the redefinition, of shared attitudes; in such studies, attitudes which are assumed to exist are built into the questions.

The relative value of qualitative and quantitative studies has been debated in the behavioral sciences for some time. A resolution generally accepted at the present time is that the qualitative study is the method of choice for generating hypotheses, and the quantitative study the method of choice for testing hypotheses (*3*). When the problem is one of delineating a shared aspect of a society-wide set of images—rather than of answering questions on which or how many students may be expected to respond in a given way—a qualitative study is preferable.

The identification of the pattern in any large sample of essays and of the cognitive and emotional processes which underlie the attitudes reported by individuals is best accomplished by trained behavioral scientists. Because any one analyst, no matter how well trained, may have some blind spots and biases, and becauses analysts differ in their types of disciplined perception, we had six different analysts work independently with six subsamples of the total sample drawn from different states. Because one kind of material may be more useful than another in outlining a given area, we used —in addition to the essay samples from the 35,000 students—a variety of other kinds of materials as well.

We are assured that we have identified important themes in the material by the multiplicity of independent analyses and by the use of a variety of data. We are assured of the validity of our conclusions by a comparison of the independent work of the analysts and by the agreement on materials from different parts of the country.

### Stages in Analysis and Validation

The stages in analysis and validation were as follows.

1) Sets of data were drawn from the main corpus by envelopes of answers, each set consisting of from 200 to 500 protocols, all from one state and including envelopes of answers to all three forms. Each of the six senior consultants was given a set of data. They worked in complete independence of one another until they met in conference to pool their results in discussion. This discussion was transcribed. The discussion indicated that the analysts were in agreement on the homogeneity of the attitudes found in the materials from different sections of

the country. On the basis of this preliminary working of the material from sample A, further collections for sample B (including provision for a control on the use of the words *American Association for the Advancement of Science*) were planned and carried out.

2) A detailed pattern analysis was performed on 1000 essays, chosen to represent both the homogeneous nation-wide sample of public schools (sample A) and the highly diversified schools (sample B). This analysis of responses (that is, items, phrases) both checked on the patterns identified by the senior analysts (among whom was included the analyst who made the detailed pattern analysis) and provided additional understanding of the patterns.

In making this analysis, essays from classes and schools were still kept together, so that each respondent could be placed and each essay could be placed within the major preoccupations of a class or a school. So some schools provided particularly clear material on the dichotomy between science as a subject for study and the personality of the scientist, or on ways in which an increasing sense of inadequacy was reflected in the rejection of science as a career. Everywhere it was possible to follow the divergent interests of boys and girls—as with the boys' interest in an active outdoor life and the girls' interest in the humanitarian aspects of medicine—but there were underlying assumptions shared by both sexes, such as the great importance of personal interests as a basis for career or marriage choice.

3) Fourteen graduate students were asked to report on smaller independent samples of essays. Graduate students were also enlisted to make collections of visual materials related to the image of the scientist in the culture of the United States today. Examples of this collection are illustrations from selected periodicals which present images of scientists, children's drawings made in response to the instruction "Draw a scientist," and the entire pictorial file from the public relations office of a pharmaceutical company.

4) Still another set of student essays from sample A was given to a seventh senior consultant, who had had no previous contact with any of the materials. Since she had not been involved in the earlier stages of the study, she could bring a fresh point of view to the final conference on the basis of which the report was written.

5) A final conference of the senior consultants was held, at which the preliminary findings were again reviewed, and the findings presented in this article were discussed in detail. There was general agreement that the findings effectively represented the data (*4*).

## The Composite Image

In reading the following composite statements, it is important to realize that they do not represent literary descriptions written by the analyst but rather composites of the responses made by the students in their essays, so that each "composite image" is to be understood as being something like a composite photograph which emerges from a very large number of superimposed photographs. Each phrase (response) both stands for a family of phrases (responses) which were used throughout the essays and is itself a recurrently used phrase (response). The phrases have been grouped in relation to themes, as they occur in the essays, but reference to the themes might occur in any order in the essays. It is important to realize that in organizing for presentation here the positive and the negative versions of the composite image of the scientist, the analyst has separated out from the answers the positive phrases (responses), on the one hand, and the negative phrases (responses), on the other hand, as an analytic device, whereas in the essays both occur—or may occur—together in a variety of combinations.

Before the image of the scientist is discussed, it will be useful to look at the way "science" appears in these essays. In the following composite statements, italics indicate the words and phrases (responses) used; detailed examples are given in parentheses, and explanatory notes in square brackets.

### Science

*Science is a very broad field* which may be seen as a single unit (*science is very important*, or *I am not interested in science*), as a melange (*medicine and gas and electric appliances*), or as composed of entities (*biology* and *physics* and *chemistry* . . . ) linked together by the personality of the *scientist*.

Science is natural science with little direct reference to man as a social being except as the products of science—*medicine* and *bombs*—affect his life. The subjects of science are *chemistry* and *physics* (*laboratories, test tubes, bunsen burners, experiments* and *explosions, atomic energy, laws* and *formulas* . . .), *biology-botany-zoology* (*plants* and *animals* [that is, as materials for laboratory work], *microscopes, dissection, the digestive system, creepy* and *crawly things* . . . ), *astronomy* (*the moon, stars, planets, the solar system, outer space, astronomers, astrologers* [*sic*], *telescopes, space ships* . . . ), *geology* (*the earth, rocks, mines* and *oil wells, out of doors* . . . ), *medicine* (*cures for TB, cancer, heart disease,* and *polio, research, serums* . . . ); *archeology* (*exploration, ancient cities, early man, fossils, digging* . . . ). *Mathematics* is not a science but a tool and a measure of scientific aptitude.

The methods of science are *research* and *experimentation, invention, discovery, exploration, finding out new things* and *new ways of improving old ones.* Science means *doing* and *making*: *hard work*—not imagination—is the source of knowledge and the means of accomplishment.

The focus of science is upon the present. The past is important only as it is left behind (*without science we would still be living in caves*) and the future as a foreseeable goal (when we *find a cure for heart disease, see if there is life on Mars, discover new fuels.* . . ). But as the past closes in behind us, the future opens to the curious (*there is still so much to discover*) into the yet unknown.

In thinking about science, different sorts of linked images occur which may be bracketed together when science is rejected or may be included when positive preference is expressed for one of a pair. So, science may be *theoretical* or *applied,* and either of this pair can be seen as more of a whole and be accepted (that is, the man in the laboratory is visualized as working through the whole problem; or the engineer can see the finished road), while the other is seen as partial and is rejected (that is, the engineer is visualized as working only on the end-product; or the man in the laboratory never sees the plan carried out). Likewise, science can be carried out *in the laboratory* or in a *far away place*; it may involve large-scale action (*traveling, digging, exploring, constructing, flying through space* . . . ) or the skills of fine detail (*gazing through a telescope, poring over a microscope, dissecting, solving equations* . . . ). The goals of science may be humanitarian (*working to better mankind, finding cures, making new products,* developing *programs for atoms for peace* . . . ), or, in contrast, they may be either individualistic (*making money, gaining fame and glory* . . . ) or destructive (*dissecting, destroying enemies, making explosives* that *threaten* the *home,* the *country,* or *all mankind* . . . ).

Since, by implication, science is the source of unlimited power, its practitioners should have the highest and the most selfless motivations to use only its constructive possibilities—or its destructive possibilities only constructively—for the *welfare of their country* and the *betterment of people, the world,* and *all mankind.*

### The scientist

#### The shared image (*5*)

*The scientist is a man who wears a white coat and works in a laboratory. He is elderly* or *middle aged and wears glasses. He is small,* sometimes *small and*

*stout,* or *tall and thin. He* may be *bald. He* may *wear a beard,* may be *unshaven* and *unkempt. He* may be *stooped and tired.*

*He is surrounded by equipment: test tubes, bunsen burners, flasks and bottles, a jungle gym of blown glass tubes and weird machines with dials. The sparkling white laboratory is full of sounds: the bubbling of liquids in test tubes and flasks, the squeaks and squeals of laboratory animals, the muttering voice of the scientist.*

*He spends his days doing experiments. He pours chemicals from one test tube into another. He peers raptly through microscopes. He scans the heavens through a telescope* [or a *microscope!*]. *He experiments with plants and animals, cutting them apart, injecting serum into animals. He writes neatly in black notebooks.*

The image then diverges.

POSITIVE SIDE OF THE IMAGE OF THE SCIENTIST

*He is a very intelligent man—a genius* or *almost a genius. He has long years of expensive training—in high school, college,* or *technical school,* or perhaps even beyond—during which *he studied very hard. He is interested in his work and takes it seriously. He is careful, patient, devoted, courageous, open minded. He knows his subject. He records his experiments carefully, does not jump to conclusions, and stands up for his ideas even when attacked. He works for long hours in the laboratory, sometimes day and night, going without food and sleep. He is prepared to work for years without getting results and face the possibility of failure without discouragement; he will try again. He wants to know the answer. One day he may straighten up and shout: "I've found it! I've found it!"*

*He is a dedicated man who works not for money or fame or self-glory, but—like Madam Curie, Einstein, Oppenheimer, Salk—for the benefit of mankind and the welfare of his country. Through his work people will be healthier and live longer, they will have new and better products to make life easier and pleasanter at home, and our country will be protected from enemies abroad. He will soon make possible travel to outer space.*

*The scientist is a truly wonderful man. Where would we be without him? The future rests on his shoulders.*

NEGATIVE SIDE OF THE IMAGE OF THE SCIENTIST

*The scientist is a brain. He spends his days indoors, sitting in a laboratory, pouring things from one test tube into another. His work is uninteresting, dull, monotonous, tedious, time consuming, and, though he works for years, he may see no results or may fail, and he is likely to receive neither adequate recompense nor recognition. He may live in a cold-water flat; his laboratory may be dingy.*

*If he works by himself, he is alone and has heavy expenses. If he works for a big company, he has to do as he is told, and his discoveries must be turned over to the company and may not be used; he is just a cog in a machine. If he works for the government, he has to keep dangerous secrets; he is endangered by what he does and by constant surveillance and by continual investigations. If he loses touch with people, he may lose the public's confidence—as did Oppenheimer. If he works for money or self-glory he may take credit for the work of others—as some tried to do to Salk. He may even sell secrets to the enemy.*

*His work may be dangerous. Chemicals may explode. He may be hurt by radiation, or may die. If he does medical research, he may bring home disease,* or *may use himself as a guinea pig,* or *may even accidentally kill someone.*

*He may not believe in God* or *may lose his religion. His belief that man is descended from animals is disgusting* (6).

*He is a brain; he is so involved in his work that he doesn't know what is going on in the world. He has no other interests and neglects his body for his mind. He can only talk, eat, breathe, and sleep science.*

*He neglects his family—pays no attention to his wife, never plays with his children. He has no social life, no other intellectual interest, no hobbies or relaxations. He bores his wife, his children and their friends—for he has no friends of his own* or *knows only other scientists —with incessant talk that no one can understand;* or else *he pays no attention* or *has secrets he cannot share. He is never home. He is always reading a book. He brings home work and also bugs and creepy things. He is always running off to his laboratory. He may force his children to become scientists also.*

*A scientist should not marry. No one wants to be such a scientist* or *to marry him.*

## Discussion

The "official" image of the scientist—the answer which will be given without personal involvement—which was evoked primarily in form I, but which recurs in the answers to all three forms, is a positive one.

The scientist is seen as being essential to our national life and to the world; he is a great, brilliant, dedicated human being, with powers far beyond those of ordinary men, whose patient researches without regard to money or fame lead to medical cures, provide for technical progress, and protect us from attack. We need him and we should be grateful for him.

Thus if no more than form I had been asked, it would have been possible to say that the attitude of American high-school students to science is all that might be desired.

But this image in all its aspects, the shared, the positive, and the negative, is one which is likely to invoke a negative attitude as far as personal career or marriage choice is concerned. While the rejection in the negative image is, of course, immediately clear, the positive image of very hard, only occasionally rewarding, very responsible work is also one which, while it is respected, has very little attraction for young Americans today (7). They do not wish to commit themselves to long-time perspectives, to dedication, to single absorbing purposes, to an abnormal relationship to money, or to the risks of great responsibility. These requirements are seen as far too exacting. The present trend is toward earlier marriage, early parenthood, early enjoyment of an adult form of life, with the career choice of the man and the job choice of the woman, if any, subordinated to the main values of life—good human relations, expressed primarily in terms of the family and of being and associating with the kind of human being who easily relates to other people.

To the extent that any career—that of diplomat, lawyer, businessman, artist, aviator—is seen as antithetical to this contemporary set of values, it will repel male students as a career choice and girls as a career for their future husbands. But it is important to see also the particular ways in which the image of a scientific career conflicts with contemporary values. It divides girls and boys. The boys, when they react positively, include motives which do not appeal to the girls—adventure, space travel, delight in speed and propulsion; the girls, when they react positively, emphasize humanitarianism and self-sacrifice for humanity, which do not appeal to the boys. The girls reject science, both as a possible form of work for themselves, concerned with things rather than with people, with nonliving things (laboratory animals, not live animals; parts of anatomy, not living children), and for their husbands, because it will separate them, give their husbands absorbing interests which they do not share, and involve them in various kinds of danger. In earlier periods, when career choices and marriages occurred later, the girls' attitudes might not have mattered so much; they are very important today, on the one hand, because girls represent a principal untapped source of technical skill, and, on the other hand, because, with present adoles-

cent social patterns, paired boys and girls spend a great deal of time discussing the style of their impending marriage and parenthood and the relationship of the boy's career choice to the kind of home they will have.

The image of the scientist's relationship to money also presents a problem, in a period of full employment, to young people who think that an adequate income is something that should be taken for granted. The scientist is seen as having an abnormal relationship to money. He is seen either as in danger of yielding to the temptation of "money and fame," or as starving and poor because of his integrity. The number of ways in which the image of the scientist contains extremes which appear to be contradictory —too much contact with money or too little; being bald or bearded; confined work indoors, or traveling far away; talking all the time in a boring way, or never talking at all—all represent deviations from the accepted way of life, from being a normal friendly human being, who lives like other people and gets along with other people.

### Specific Indications about the Teaching of Science

From the standpoint of teaching, it is important to realize how the present image of scientific work lacks any sense of the delights of intellectual activity; the scientist works patiently and carefully for years, and only when he finds out something does he shout with joy. This lack of any sense that intellectual activity is rewarding in itself can be related to the lack of any mention of living things, plant, animal, or human, in the materials with which the scientist is believed to work. Plants and animals appear only as dead objects for dissection; the human body, as organs or systems studied in the laboratory and treated in medicine; whole human beings appear only as the dead denizens of dead and buried cities, and most of the scientists about whom they read are also dead. The lack of any sense of enjoyment can also be related to the central role given to mathematics as a tool, without any emphasis on the delights of observation, as in early natural history studies or in the perception of regularities and connections in the world around them, or between themselves and the world around them.

Because the materials were analyzed class by class and school by school, the study has also yielded, as a by-product, certain sidelights on science teaching: on the importance of participation as opposed to passive watching, on the role which the personality of the teacher plays in attitudes toward science, on the effect on the rest of the class of the presence in it of one type of exceptionally gifted child.

One of the most recurrent responses is an expression of active boredom, the phrase, "I am not interested in science," or in a particular science course (chemistry or physics), followed occasionally by highly emotional expressions of fury and hatred of particular activities which are being demonstrated. "Interest" and "active enjoyment" seem to be so closely related that the student seated in a classroom who has to watch things being poured from one test tube to another or listen to a string of unrelated facts becomes permanently alienated. General science courses seem to be the ones in which this attitude toward science is characteristically invoked, except when a gifted teacher gives it some special emphasis. When mathematics is seen as the key ability on which all future scientific work is based, not liking and not being able to do mathematics become a specially weak point in the circle of the students' interests.

In contrast, other activities are defined as nonscientific because they are absorbingly interesting: "watching things grow that I have planted," or "working on my hot rod car."

The role of the teacher—as reflected in the comments of a whole class—is an exceedingly interesting one. The disliked teacher is personalized and vivid, but the teacher who has obviously been very successful and has caught the imagination and enthusiasm of the whole class does not emerge as a person at all but, instead, sinks into the background of good classroom conditions, together with "good laboratory equipment." Special aspects of the disliked teacher are commented on in detail. He may be described as an outsider, a stranger, with unusual habits of dress and manner, who does not know his subject well, who cannot talk about anything but his subject, who lives alone without the slightest tie to the community, who is "stuck-up and who is too busy for anyone but himself." It is easy to see how the only male teacher in the school presents special problems to the boys, if he himself is a figure they reject, and how easily the sphere of work for which he stands may be rejected also. So one boy writes, "Anyone who digs our teacher's gab is a square as well as being queer." Some of these consequences undoubtedly flow from the convention in the United States that, ideally, science should be taught by men, with the result that men who might be more successful teachers in some other field are forced into teaching a subject which they dislike and in which they have no special competence. Similarly, foreigners and refugees—if male—may have a better chance to get positions as mathematics and science teachers than they have in other fields (*8*).

The significance of the lack of particular mention of the good science teacher is equally important, for it is related to the lack of invocation of authority by the students, who state their opinions about science—even those obviously related to a particular teacher—as their own. Only when they disagree, when they wish to attack the current image of science as a good thing from a minority position—that is, from the viewpoint of some fundamentalist religious position which they accept—do they invoke authority. It is related also to the situation in American culture where, through generations, there has been a break between immigrant parent and native-born child. In this new setting, the European tendency for children to identify with the personality and occupation of the parents has been replaced by a tendency to follow the style set by members of one's own generation, especially those in one's own local school clique.

In the classroom, a disliked fellow-student who is regarded as a future scientist may also be described in some detail, as students say they do not want to be the kind of scientists who "go about with their noses in a book, looking superior." But in those classrooms where everyone has been committed to the joy of some experiment or project, no individuals emerge: it is impossible to say what is the sex, age, nationality, and personality of the teacher.

In summary, it may be said that where science teaching is successful, the teacher has created a situation in which his or her (one does not know which) personality sinks into the background, and in which no one student stands out as so especially gifted and preoccupied as to rouse annoyance in the class. Students and teacher appear to have worked as a group, accepting science as a part of *their* lives, preoccupied with no specific identified individuals.

### Recommendations

*Mass media.* Straight across the country there is a reflection of the mass media image of the scientist, which shares with the school materials the responsibility for the present image. Alterations in the mass media can have important consequences in correcting the present distorted image if such changes are related to real conditions. Attempts to alter the image, in which the public relations department of a particular company represents its research personnel with crew cuts and five children may improve the recruitment program of single com-

panies, but do so only at the expense of intensifying the negative aspects of the image for the country as a whole.

What is needed in the mass media is more emphasis on the real, human rewards of science—on the way in which scientists today work in groups, share common problems, and are neither "cogs in a machine" nor "lonely" and "isolated." Pictures of scientific activities of groups, working together, drawing in people of different nations, of both sexes and all ages, people who take delight in their work, could do a great deal of good.

The mass media could also help to break down the sense of discontinuity between *the scientist* and other men, by showing science as a field of endeavor in which many skills, applied and pure, skills of observation and of patient, exact tabulation, flashes of insight, delight in the pure detail of handling a substance or a material, skills in orchestrating many talents and temperaments, are all important. This would help to bring about an understanding of science as a part of life, not divorced from it, a vineyard in which there is a place for many kinds of workers.

*The schools.* The material suggests the following changes which might be introduced in educational planning.

1) Encourage more participation and less passive watching in the classroom, less repeating of experiments the answers to which are known; give more chance to the students to feel that they are doing it themselves. A decrease in the passive type of experience found in many general science courses seems particularly necessary.

2) Begin in the kindergarten and elementary grades to open children's eyes to the wonder and delight in the natural world, which can then supply the motive power for enjoyment of intellectual life later. This would also establish the idea of science as concerned with living things and with immediate—as contrasted with distant—human values.

3) Teach mathematical principles much earlier, and throughout the teaching of mathematics emphasize nonverbal awareness (*9*): let children have an opportunity to rediscover mathematical principles for themselves.

4) Emphasize group projects; let the students have an opportunity to see science as team work, where minds and skills of different sorts complement one another.

5) Emphasize the need for the teacher who enjoys and is proficient in science subjects, irrespective of that teacher's sex; this would mean that good women teachers could be enlisted instead of depending on men, irrespective of their proficiency. Since it would seem that the boys do not need to identify with an adult male as a teacher, this should leave us free to draw on women as a source of science teachers.

6) Change the teaching and counseling emphasis in schools which now discourages girls who are interested in science. This would have many diffuse effects: on the supply of women teachers and of women in engineering, on the attitudes of girls who are helping boys to choose careers, and on the attitudes of mothers who are educating their small children in ways which may make or mar their ability to deal with the world in scientific terms.

7) Deemphasize individual representatives of science, both outstanding individuals like Einstein—whose uniqueness simply convinces most students that they can never be scientists—and the occasional genius-type child in a class. (This type of child, who represents only one kind of future scientist and who is often in very special need of protection from the brutalities of his age mates, should probably be taken out of small, low-level schools, and placed in a more protected and intellectual environment.) Instead, emphasize the sciences as fields, and the history of science as a great adventure of mankind as a whole. (The monotonously recurrent statement "if it weren't for scientists we would still be living in caves" is an insult to the memory of millions of anonymous men who have—each in his way—made further advances possible.)

8) Avoid talking about *the scientist, science,* and *the scientific method.* Use instead the names of the sciences—biology, physics, physiology, psychology—and speak of what a biologist or a physicist does and what the many different methods of science are—observation, measurement, hypotheses-generating, hypotheses-testing, experiment.

9) Emphasize the life sciences and living things—not just laboratory animals, but also plants and animals in nature—and living human beings, contemporary peoples, living children—not the bones and dust of dead cities and records in crumbling manuscripts. Living things give an opportunity for wonder and humility, necessarily less present in the laboratory where students deal with the inanimate and the known, and contact with living things counteracts the troubling implication that the scientist is all powerful.

## Conclusion

This report is not in any way a statement of the proportion of high-school students who will choose science as a career. It is a discussion of the state of mind of fellow-students, among whom the occasional future scientist must go to school, of the degree of personal motivation necessary to commit oneself to science, and of the atmosphere within which the science teacher must teach. Since most high-school students' attitudes closely reflect those of their parents, it is also an indication of the climate of opinion in which parents may be expected to back up their children in choosing science as a career, citizens may be expected to vote funds for new laboratories, and voters may be expected to judge Congressional appropriations for science education.

### References and Notes

1. To control any possible influence which the wording of this statement might have, part of sample B was collected without reference to the association. No difference in the formulation of the replies was found when the association was mentioned and when the association was not mentioned.
2. In six of the schools included in sample B, all three forms—to be used by different classes—were sent to the same school.
3. There are a number of different quantitative studies of the broader subject under way: those directed by H. H. Remmers in the Division of Educational Reference at Purdue University, on high-school students' attitudes toward science; a study at the Survey Research Center at the University of Michigan on attitudes of the public toward science writing; two studies under the Science Manpower Project at Teachers College, Columbia University, one by Hugh Allen, on "Attitudes toward science and scientific careers: a research inventory for New Jersey high-school seniors," and a second by Frances Hall, on science teachers' attitudes toward science. The Interim Committee on Studies on the Social Perception of the Satellite Program and Personnel, under the chairmanship of Donald Michael of Dunlap Associates, Stamford, will also cover some overlapping areas.
4. For assistance in this study through the Institute for Intercultural Studies, which cooperated with the American Association for the Advancement of Science, we wish to thank Ruth Bunzel, Edith Cobb, Natalie Joffe, Martha Wolfenstein, Mark Zborowsky, also graduate students in Columbia University anthropology courses GS 271-2 and GS 198, and, for criticism of the report, Robert Weiss of the Survey Research Center, University of Michigan.
5. A few of the more mature students realize that this picture is stereotyped and incomplete. So, for instance, having described the scientist as the "man in the white coat," students continue: "On second thought—he might equally well be seining a small stream, feeding facts into an electronic computer, or injecting a radioactive fluid into the veins of a monkey" (boy, 17, 12th grade). "I realize that there is more than microbiology [that is, the man in the white coat] to science. Therefore, I think of the atom, and somehow always of old men, working on various bombs and reactors. When I think of the use of atoms for peace, I think of young men working in offices. I don't know why" (girl, 14, 10th grade). "At the word *science,* I can imagine so much. The scope is unlimited and I sometimes do not connect the two words [*science* and *scientist*] any further than the laboratory. But if I could put the two together, a scientist would become more of an adventurer, a romanticist, than a figure who is nothing but a human IBM machine" (boy, 15, 10th grade).
6. When evolution is mentioned, it is mentioned negatively. It is impossible to tell what the absence of other than negative references to evolution means. In Remmers' study [H. H. Remmers and D. H. Radler, *The American Teenager* (Bobbs-Merrill, Indianapolis, Ind., 1957), p. 171] 40 percent of the teenagers checked "No," to the statement "Man has

evolved from lower forms of animals"; another 24 percent checked "Don't know"; 35 percent checked "Yes."

7. In this statement, we draw not only on the attitudes in this study but on a wide variety of other materials on the attitudes of contemporary young Americans.
8. The other side of this picture is sometimes seen in comments made by foreigners who have entered the sciences because Americans think they require less of a knowledge of the culture, and who because of their science training can get teaching positions in the schools. After a year or two of teaching in small-town schools, the foreign-born teacher flees back to the cities where he has friends or at least can live anonymously. (Based on life-history data from Chinese informants in the Chinese section of the Study Program in Human Health and the Ecology of Man, New York Hospital–Cornell Medical College, New York.)
9. Studies of the College Entrance Examination Board Commission on Mathematics and the University of Illinois Committee on School Mathematics give promise of bringing about improvement in mathematics instruction. A study of junior-high-school mathematics will be undertaken at the University of Maryland this fall. There is more to be done, especially in the elementary grades, and state departments of education should be encouraged to establish state committees which can determine how work now in progress at the national level can be made effective in local schools. The Poloidi-blocs, developed by Margaret Lowenfeld of the Institute of Child Psychology, 6 Pembridge Villas, London, W.11, are an important addition to the equipment for teaching young children mathematics.

# A. S. King, Spectroscopist

Arthur Scott King was born 18 January 1876 in Jerseyville, Illinois. In 1883 the family moved to Santa Rosa, California and, about 1890, to Fresno, where Arthur received his secondary education. In 1895 he entered the University of California at Berkeley; here, in 1899, he received the B.S. degree and, in 1901, the M.S. In 1903 he received the first Ph.D. degree in physics ever awarded by the university. He was assistant instructor in physics at the university from 1901 to 1903. He spent the years 1903 and 1905 in Bonn, Germany, where he was a pupil of H. Kayser, who was then publishing the early volumes of his monumental *Handbuch der Spectroscopie*.

King's professional career really began in 1905, when he was appointed instructor in physics at the University of California. In January 1908 he was appointed superintendent of the physics laboratory at the Mount Wilson Solar Observatory, as it was called at that time. Here he remained until his retirement in 1943, and here, under George E. Hale's dynamic leadership, King chose detailed studies of atomic spectra for his life's work. The atmosphere of the observatory was vibrant with new ideas and the promise of rapid developments. Hale had shown that strong magnetic fields occur in sunspots. The spectroheliograph was daily revealing new information concerning phenomena on the sun. The 60-foot tower telescope was completed, the 60-inch reflector was to go into service at the end of the year, and the new physics laboratory in Pasadena was to be occupied in May.

King was a pioneer in the study of thermal excitation of atomic spectra and in the classification of lines in the complicated spectra of metallic atoms. When Hale suggested to him the study of the effects of temperature on atomic spectra, the immediate objective was the interpretation of solar data. King's work did indeed supply invaluable information on the relative temperatures of sunspots and the normal solar disk. But it did more. It created a powerful means of analyzing atomic spectra and of assisting in the development of the quantum theory of the atom.

The electric furnace which he designed was set up in the new laboratory in 1908. A horizontal graphite tube containing the substance to be studied was heated to the desired temperature by a powerful electric current. Light from the vaporized material left one end of the tube to enter a spectrograph. Light from the other end of the tube went to an optical pyrometer, which determined the temperature. The visible and near-ultraviolet parts of the spectra of numerous elements were recorded, at temperatures of from 1600° to nearly 3000°K. On each spectrogram were also recorded arc spectra of the same substance that was used in the furnace. With painstaking attention to detail, King estimated the intensities of many thousands of lines on photographs of furnace and arc spectra. These data led to a classification of the lines of each element according to the temperature required for their appearance. Five main temperature classes made up the system, which was the forerunner of the present quantum classification.

In those early days it was well known that heated substances would produce continuous spectra, but some physicists doubted that heat alone would produce discrete emission lines. They thought that the emission of lines from King's furnace somehow depended on the fact that the carbon tube was electrically heated. Because the voltage was low (from 6 to 10 volts), King did not think that this was true, but, to make perfectly sure, he made other photographs of the emission lines, exposing the film only during intervals when the electric current was shut off. His observations steered thinking about spectra in the right direction and were later of tremendous importance in the sorting out of spectrum lines according to the quantum theory of atomic structure.

King engaged in other scientific activities that were of considerable importance. In his early years he investigated the Zeeman effect in lines of titanium, iron, and other metals. Later he studied spectra of meteorites. He was codiscoverer, with Raymond T. Birge of the University of California, of the isotope carbon-13, and he collaborated with R. F. Sanford of the Mount Wilson Observatory staff in studying carbon isotopes in N-type stars. During World War I he investigated phenomena of sound in water. After his retirement, in 1943, he worked for several years at the Pasadena office of the Naval Ordnance Test Station.

King had a delightfully gentle personality and was beloved by all who knew him. After months of illness he passed away at his home in Pasadena, on 25 April 1957.

HAROLD D. BABCOCK
*Mount Wilson and Palomar Observatories, Pasadena, California*

# News of Science

## Plasmin

A research team at Yale University has described significant progress in purifying a plasmin enzyme that dissolves blood clots. Daniel L. Kline, associate professor of physiology, and Jacob B. Fishman, research associate in physiology, report that plasmin has been tested successfully on animals and that preliminary tests on human patients are now under way.

In human patients, plasmin will be injected into the blood stream as soon as the blood clot is detected. The clot, judging from the animal experiments, should dissolve and the blood return to normal within a few hours. While there are drugs that help prevent the formation of blood clots, up till now physicians have had no drugs that will dissolve a clot once it has formed.

The big problem with plasmin, however, is purification. Plasmin is derived from the interaction of two other enzymes, plasminogen and streptokinase. Plasminogen is an inactive enzyme extracted from human blood provided by the American Red Cross. To activate plasminogen and form plasmin, streptokinase is needed. This enzyme is obtained from streptococcal bacteria that contain toxic materials which lower the supply of blood to the heart muscle, lower blood pressure, and cause chills and fever. Although the investigators at Yale have not yet achieved 100-percent purification of plasmin, they feel that they have found a method for removing enough of its toxic material to warrant tests on human patients.

It was Kline who made a major find in blood-clot research in 1953 when he developed a method for purifying plasminogen. In 1955 he and Fishman developed a method for the partial purification of plasmin.

Clinical tests on human patients are being conducted by Julian Ambrus, Joseph Sokal, and associates at Roswell Park Memorial Institute in Buffalo, N.Y. William Glenn, associate professor of surgery at Yale, and his colleagues are working on new tests with laboratory animals.

Important research on plasmin is also being carried out by scientists in other parts of the country, notably by William S. Tillett of New York University and Sol Sherry of St. Louis University. The Tillett-Sherry approach, however, differs from that of the Yale team in that Tillett and Sherry are working on methods of injecting streptokinase directly into the blood stream. This approach assumes that the body has enough plasminogen of its own to be activated by the streptokinase injection, and that plasmin will form within the blood stream and then seek out any blood clots that must be dissolved.

## Neurological Research Foundation

The National Neurological Research Foundation has been established at the suggestion of some of the country's leading neurologists. It plans to found research fellowships and support research in the study of the nervous system and such diseases as Parkinson's syndrome, cerebral palsy, multiple sclerosis, amyotrophic lateral sclerosis, muscular dystrophy, epilepsy, senile psychosis, and other related conditions.

The foundation plans to give investigators full scope in studying these diseases as a whole and in relation to one another, rather than fragmented and split into isolated categories. Eight United States medical scientists will serve as members of the Scientific Advisory Committee, which will choose fellows and research projects for study in neurological disorders for which there are no known cures today. Members of the committee are as follows: Raymond D. Adams, Bullard professor of neuropathology, Harvard Medical School, and chief of the Neurological Service, Massachusetts General Hospital; Edward M. Dempsey, professor and head of the department of anatomy, Washington University; Louis S. Goodman, professor of pharmacology, University of Utah; Seymour S. Kety, professor of clinical physiology, University of Pennsylvania (on leave), and chief of the Laboratory of Clinical Science, National Institute of Mental Health; Oliver Lowry, dean and professor of pharmacology, Washington University; Horace W. Magoun, professor of anatomy, University of California, Los Angeles; James L. O'Leary, professor of neurology, Washington University; A. Earl Walker, professor of neurological surgery, Johns Hopkins Medical School.

In order to provide the research scientists with economic security, fellowships of from $10,000 to $12,000 yearly for a period of 5 years will be offered. The foundation program will in no way conflict with established efforts in the field; rather, it will concentrate effort on fellowships and research only. The foundation plans no clinical or rehabilitation centers.

Funds to finance the foundation's work will be raised through donations from the public and through other foundations' interest in medical research fellowships and research.

Contributions in any amount, however small, will be accepted. A fellowship supported entirely by a single group or donor will be named according to his or her wishes. The donor will be notified of the name of the fellow or fellows, the nature of the work, and where it is being done. Contributions will go directly to the account established for the National Neurological Research Foundation at the National Bank of Washington, Washington, D.C. Foundation headquarters are at 3255 N St., NW, Washington, D.C.

The officers of the new organization include: honorary president, Fuller Albright, associate professor of medicine, Harvard Medical School; treasurer, Barnum L. Colton, president of the National Bank of Washington; chairman, the Honorable William Marvel, vice chancellor of the State of Delaware; vice chairman, Mark D. Altschule, assistant professor of medicine, Harvard Medical School; executive secretary, Rodgers Denckla, 3255 N St., NW, Washington, D.C.

## Standard Oil's 75th Anniversary Aid to Science Teaching

As one of several activities marking its 75th anniversary, Standard Oil Company of New Jersey is making a grant of $1.5 million to the Esso Education Foundation to finance a 3-year program to advance the teaching of science and engineering. Although the program covers 3 years, commitments will be made from year to year. Thus, when it is found advisable, support may be given to some new area not now contemplated. The features of the first year's program are as follows.

At the secondary level, opportunities will be provided for teachers to bring their background up to date through two summer institutes and one in-service institute. The summer institutes, to be

held on college campuses, will last from 6 to 8 weeks. The foundation's grant will meet expenses of the host institutions and provide board, room, tuition, traveling expenses, and a stipend to the teachers to help compensate for loss of summer earnings.

The in-service institute will enroll 100 public, private, and parochial school teachers in a metropolitan area university for a course of 27 Saturday sessions. The foundation's grant will meet the expenses of the university and provide a stipend to each teacher to help offset the loss of part-time employment. This project, based on strong recommendations from high-school and college educators, is a pilot operation and may be extended to other cities.

In both of these programs, teacher selection will be exclusively in the hands of the participating colleges. In order to encourage development of up-to-date instructional materials, support may be given to a project on the use of films or television for science teaching.

At the college undergraduate level, unrestricted funds will be provided to science and engineering departments. These might be used to purchase books and laboratory equipment and to permit faculty members to attend meetings, visit plants and scientific projects, prepare papers for publication or as teaching material, and conduct special research. The latter might include summer vacation projects, which could thus be conducted without loss of income otherwise obtainable from outside employment.

Capital grants to assist in the construction of new science buildings will be made to certain institutions that have undertaken such building programs. These grants will be in addition to capital grants usually made by the Esso Education Foundation.

At the graduate level, unrestricted grants will be made to departments of science and engineering. College authorities will have complete responsibility for selecting specific activities and individuals and otherwise directing disposition of the grants.

## NSF Earth Science Grants

The Earth Science Program of the National Science Foundation is now receiving proposals for research grants that will be made in February and March 1958. Deadline for the receipt of proposals for work to begin in the fall or early winter is *20 Sept.* There are no formal application blanks, but an NSF pamphlet that describes the method of making application may be obtained by writing to the Earth Sciences Program, National Science Foundation, Washington 25, D.C.

## Swedish Scientists Visit U.S.

Twenty-six members of the Swedish Association of Young Scientists spent August visiting U.S. research laboratories on a study tour sponsored by the National Academy of Sciences and the American-Scandinavian Foundation in New York. The decision to come to the United States was an abrupt change from previously announced plans. For some years the group had been making annual exchange visits with scientists of other European countries. In 1957 a trip to the U.S.S.R. was scheduled, to be followed by a return visit from the Soviets in 1958. However, after the events of the Hungarian uprising, the Swedish Association canceled the original plans.

While the Swedish scientists have themselves raised the funds for transatlantic passage and insurance, their expenses over here were financed by private contributions. Cosponsorship of the study tour was undertaken by the National Academy as part of its continuing program of facilitating U.S. participation in international science organizations and encouraging professional cooperation among scientists of all nations.

## New Electronic Devices

Two new electrochemical devices which may rival the vacuum tube and the transistor in electronic technology have been announced. They are the "solion," developed by the Naval Ordnance Laboratory in Washington, D.C., and the "spacistor," developed by a team of physicists of Raytheon Manufacturing Company of Waltham, Mass.

The "solion" depends on the movement of ions in a solution, instead of in gas or a vacuum, as in the vacuum tube, or in a solid, as in the transistor. The ions flow between electrodes in an iodine solution. The device is highly sensitive to changes in outside conditions. The electric flow of ions, for example, can be stimulated and varied by changes in temperature, pressure, light, sound, and acceleration. In certain applications, it promises to be more selective, sensitive, and efficient than the vacuum tube or the more recently developed transistor. It is expected to make possible less expensive, smaller, and simpler electronic control systems.

The "spacistor" operates on what is described as "a wholly new principle." It is a semiconductor device, as tiny as the transistor, that operates electrically like a vacuum tube. It is said to "combine many of the best properties of the vacuum tube and the transistor" and thus to be "a major step forward in the art of amplifying electric energy." The spacistor promises two major advantages over today's best transistors: it will probably amplify as much as 50 times higher than transistors; also, because spacistors can be made from materials unsuited for transistors, they are expected to operate at temperatures more than double the temperatures at which today's germanium or silicon transistors can operate.

## Teacher Exchange Program

More than 500 teachers from the United States and 37 other countries will participate in the 1957–58 program of exchange teaching arranged by the U.S. Office of Education. The teacher exchange program is now in its 12th year. It began in 1946–47 with an exchange of 74 American and 74 British teachers. With this year's exchange, 4273 teachers from the United States and 57 other countries will have participated in the program, which is part of the United States International Educational Exchange program of the Department of State.

The teacher exchange program is the forerunner of another program of international education arranged by the Office of Education. Under this latter plan more than 475 additional teachers and school administrators will be arriving during the fall months. They will participate in the International Teacher Education Program of the Technical Assistance Program, which is administered by the Office of Education in cooperation with the International Educational Exchange Service and the International Cooperation Administration, respectively, in the Department of State.

## Mathematics Teaching Essay Contest

During the school year 1956–57, Kappa Mu Epsilon, honorary mathematics fraternity, and the AAAS Science Teaching Improvement Program sponsored an essay contest for teachers of mathematics and prospective teachers. Thousand-word essays on "Opportunities in teaching mathematics in secondary schools" were submitted by contestants. Prizes were awarded to Sister Mary Neal Moran, Mundelein College, Chicago, Ill.; Rose Mary Kotesa, College of St. Francis, Joliet, Ill.; and Cathleen Real, Davenport, Ia.

The winning essays will appear in the fall issue of *Pentagon*, official publication of Kappa Mu Epsilon. It is hoped that the contest and the resulting published essays will encourage undergraduate and graduate students in mathematics to consider the advantages of a career in secondary-school mathematics teaching.

## U.S. Physicians Touring U.S.S.R.

Five public health physicians are on a 4-week exchange mission to the U.S.S.R., the first such public health mission since World War II. A reciprocal Soviet mission will visit the United States in October.

Thomas Parran, dean of the Graduate School of Public Health at the University of Pittsburgh and a former Surgeon General of the U.S. Public Health Service, is heading the American group. Other members are Malcolm Merrill, California state director of public health; Otis L. Anderson, an assistant surgeon general of the U.S. Public Health Service; H. Van Zile Hyde, a medical director with the USPHS; and Leonid Snegeriff, associate professor at the Harvard School of Public Health.

## Zoological Nomenclature

The International Commission on Zoological Nomenclature has announced that, beginning 26 Feb. 1958, it will start voting on the following cases involving the possible use of its plenary powers for the purposes specified against each entry. Full details of these cases were published on 26 Aug. in the *Bulletin of Zoological Nomenclature* (vol. 12, pt. 12 and vol. 13, pt. 8): (i) *parvula* Mörch, 1863 (*Aplysia*), validation (cl. Gastropoda); (ii) *Anodonta* Lamarck, 1799, validation (cl. Pelecypoda); (iii) *padi* Linnaeus, 1758 (*Aphis*), validation (cl. Insecta, order Hemiptera); (iv) and (v) *lineata* Young and Bird, 1828 (*Terebratula*), and *subconcinna* Davidson, 1852 (*Rhynchonella*), interpretation (cl. Brachiopoda); (vi) *anonyma* Lewis, 1872 (*Liminitis*), suppression (cl. Insecta, order Lepidoptera); (vii) *obtusa* Montagu, 1803 (*Bulla*), validation (cl. Gastropoda).

A proposal is also made for the adoption of a *Declaration* clarifying the status of adjectival specific names consisting of partly Latinized words. Comments should be sent as soon as possible in duplicate to the secretary of the commission, Francis Hemming, 28 Park Village East, Regent's Park, London, N.W.1, England.

## Lederle Medical Awards

The Lederle Medical Faculty awards are offered by the Lederle Laboratories Division of American Cyanamid Company to assist able men and women who are working and contemplating further careers in the preclinical departments of medical schools. The program provides financial aid for a limited period in the support of individuals who have demonstrated capacities both as teachers and investigators in departments of anatomy, biochemistry, microbiology, pathology, pharmacology, and physiology.

The awards are designed for persons who have progressed beyond the state of development now encompassed by postdoctorate fellowships and are made for a term not exceeding 3 years. Recipients of Lederle Medical Faculty awards must hold "faculty rank," such as instructor or assistant professor (or their equivalent, as determined by the committee), in their medical schools and should be individuals who give promise of staying on to continue teaching and research within the disciplines indicated. Individuals chosen for the awards have full privileges and responsibilities for teaching and research as regular faculty members in the sponsoring department.

Nominations for Lederle Medical Faculty awards should be submitted to the committee through the office of the dean of the medical school and should be endorsed by him and by the administrative head of the sponsoring department. Only one candidate from any one school will be considered in any given year.

## News Briefs

In September a group of 13 Japanese scientists will begin a 7-month ethnological and archeological survey of southeast Asia in an effort to determine the origin of the Japanese race. The research team will also study the cultural and basic social structure of the various rice-growing communities in Thailand, Cambodia, Laos, and South Viet-Nam.

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The Westinghouse Educational Foundation has announced that it has increased to $34,250 the total value of 40 science scholarships and awards for which high-school seniors may compete during the coming school year in the 17th annual nation-wide Science Talent Search. This more than triples the amount of the awards. The Science Talent Search is conducted by the Science Clubs of America and is administered through Science Service.

* * *

Eight nations are supporting a plan adopted at the recent Geneva meeting of the World Health Organization for a comparative study of the various types of cancer found in different countries. The eight nations are Australia, France, Iran, the Netherlands, Poland, the Soviet Union, Britain, and the United States.

* * *

A study to determine to what extent antibiotic drugs are losing their effectiveness against certain infections has been announced by the Veterans Administration. Six VA hospitals and Canada's Department of Veterans Affairs are cooperating in the project, which will be directed by Max Bovarnick of the Brooklyn, N.Y., VA hospital.

* * *

The United States Government formally took possession of the $500-million Distant Early Warning radar line this month. A ceremony included a demonstration to show how the line would flash an alarm of approaching enemy bombers. The Air Force hopes that the 3000-mile line across the rim of the continent will provide 2 to 4 hours' warning.

* * *

The Greek Government has approved the founding of an atomic energy agency to implement Greece's nuclear-energy program, which the United States is helping to establish. The agency will set up the country's first nuclear reactor installations for experimental purposes.

* * *

The Rockefeller Institute for Medical Research is issuing the *Rockefeller Institute Quarterly*, a new publication to report institute activities, primarily for faculty and present and former staff members. Charles I. Campbell is editor.

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A course on air pollution meteorology will be conducted 16–27 Sept. at the Robert A. Taft Sanitary Engineering Center of the U.S. Public Health Service, Cincinnati, Ohio. Enrollment is by application; however, there is no tuition requirement.

## Proposed Legislation

Of the many bills introduced in Congress, some have a special relevance to science and education. A list of such bills introduced recently follows:

HR 8804. Provide a program for development of minerals resources of U.S., its territories, and possessions, by encouraging exploration for minerals. Baring (D Nev.) House Interior and Insular Affairs.

HR 8945. Protect public health by amending Federal Food, Drug, and Cosmetic Act to prohibit use in food, drugs, and cosmetics of color additives which have not been determined suitable and harmless for such use. Curtis (R Mo.) House Interstate and Foreign Commerce.

HR 8992. Provide for appointment of representatives of U.S. in organs of International Atomic Energy Agency, and make other provisions re participation of U.S. in that agency. Price (D Ill.) Joint Committee on Atomic Energy.

HR 8947. Provide that cigarettes sold in interstate commerce be packaged and marked so as to show the nicotine content and the tar content of the cigarettes

in each package. Fino (R N.Y.) House Interstate and Foreign Commerce.

* * *

The public laws enacted recently that relate to science and education include:

S 2212. Amend North Pacific Fisheries Act of 1954 to extend federal authority to regulate U.S. fisheries operations on high seas. Magnuson (D Wash.) Senate Interstate and Foreign Commerce reported 14 June, Senate passed 26 June, House passed 15 July, President signed 24 July.

S 2250. Amend Act of 5 Aug. 1955 authorizing construction of two surveying ships for Coast and Geodetic Survey, Department of Commerce. Magnuson (D Wash.) Senate Interstate and Foreign Commerce reported 26 June, Senate passed 3 July, House passed 15 July, President signed 24 July.

## U.S. Isotopes to U.S.S.R.

In its 22nd semiannual report to Congress, the Atomic Energy Commission reported that it had approved a first shipment of radioactive isotopes to the Soviet Union for use in medical research. A paragraph in the report read: "The first application for a license to export radioactive isotopes to Soviet Russia was received and approved. It covered a small amount of (radioactive) carbon-14 which will be used for cancer research at the Bio-Chemical Institute of the Academy of Science, Moscow."

## September Scientific Monthly

Articles appearing in the September issue of *The Scientific Monthly* are "World population in relation to potential food supply," W. H. Leonard; "Training of a scientist," V. C. Morris; "Rocket exploration of the upper atmosphere," N. W. Spencer; "Sadi Carnot," M. Kerker; "American medical mission to the Soviet Union," J. R. Paul. Fourteen books are reviewed.

## Scientists in the News

JULIUS H. COMROE, JR., chairman of the department of physiology and pharmacology at the University of Pennsylvania Graduate School of Medicine, has been named professor of physiology and director of the new Cardiovascular Research Institute at the University of California Medical Center, San Francisco. The institute will be devoted to research on diseases of the heart and circulatory system. Quarters for the new facility, which will occupy the 13th floor of Herbert C. Moffitt Hospital, are now under construction and are to be completed by July 1958. Several of the institute's research programs are in progress, however, and Comroe has already assumed his new duties.

OTIS L. ANDERSON, chief of the U.S. Public Health Service's Bureau of State Services, has been assigned to the new office of assistant surgeon general for personnel and training that has been established in the office of the Surgeon General, USPHS. Anderson will be succeeded in the Bureau of State Services by DAVID E. PRICE, now deputy chief of the USPHS Bureau of Medical Services. The changes will become effective on 1 Oct.

JOHNSON E. LUTON, JR., has been appointed assistant director for administration of the National Science Foundation. He succeeds WILSON F. HARWOOD, who recently resigned to accept a position as director of the Governmental Affairs Institute's Management Project in Iran. Luton joins the foundation from the National Council of Churches, New York, where for nearly 4 years he has been assistant general secretary in all matters concerned with budgeting, organization and management, personnel, treasury and accounting, business services, and publications and distributions.

This year's honorary degree recipients include the following: FRANKLIN C. McLEAN, emeritus professor of skeletal physiology at the University of Chicago, from the University of Lund, Sweden; RICHARD E. SHOPE, professor at the Rockefeller Institute for Medical Research, from the University of Giessen, Germany; PAUL WEISS, professor at the Rockefeller Institute for Medical Research, from the University of Giessen, Germany.

E. S. HISCOCKS has been appointed director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Office in Washington, D.C. He will also serve the British Embassy as attaché for scientific questions. Hiscocks, secretary of the National Physical Laboratory for the past 12 years, succeeds H. J. HADOW, who has completed his term of office in Washington and will return to duty with the Department of Scientific and Industrial Research in England. Hadow has been appointed secretary of the National Physical Laboratory.

THOMAS M. DAVIS, pioneer in radio, is retiring from the U.S. Civil Service after a career of nearly 47 years with the Navy. Davis, an employee of the U.S. Naval Research Laboratory since its opening year, is head of the radio techniques branch of the Radio Division. After joining the Navy in 1910, he worked with spark, arc, and vacuum tube transmitters and took the initiative in conducting the first demonstrations of voice and music radio transmissions from a ship at sea during maneuvers of the *U.S.S. Wyoming* with the British fleet in 1918.

After World War I, Davis joined the staff of the Radio Laboratory at the Washington Navy Yard, and in 1920 he undertook the leadership of a group engaged in the development of Navy radio communication receivers. In 1923, Davis and his group were transferred to the Naval Research Laboratory, where he assumed the responsibility for conducting a program of research and development on radio receivers for communication and navigation. He and the scientists of his branch have provided the principal support for the Navy in the radio receiver field.

HAL G. JOHNSON, director of general development in the Monsanto Chemical Company's Research and Engineering Division, has been elected a vice president of the Vick Chemical Company.

Col. HAROLD WALMSLEY has assumed command of the Army Chemical Center and Chemical Corps Materiel Command, Edgewood, Md., where he replaces Brig. Gen. MARSHALL STUBBS, who has been assigned to the headquarters of the 1st Logistical Command at Fort Bragg, N.C. For the past 2 years Walmsley has been commanding officer of the U.S. Army Chemical Procurement Office in New York.

DANIEL ALPERT, associate director of Westinghouse Research Laboratories, has accepted an appointment as research professor of physics and technical director of the control systems laboratory at the University of Illinois. Alpert will continue to be associated with Westinghouse as a consultant to the laboratories, including work on Project Sherwood, the Atomic Energy Commission project aimed at harnessing nuclear fusion for useful power purposes.

EDWARD L. JENKINSON will retire on 1 Sept. as chairman of the department of radiology at Northwestern University Medical School. He is succeeded by FRED E. BARTH, professor of radiology.

Jenkinson joined the medical school faculty in 1919 as an instructor in radiology. He has held his present post since 1947. During his years at Northwestern he has become well known for his work on the x-ray diagnosis of gastrointestinal diseases. In 1954 he was chosen to deliver the annual Caldwell lecture to the

American Roentgen Ray Society, one of the highest honors in the field of radiology.

JOHN H. MANLEY has been named a research adviser at the University of California's Los Alamos Scientific Laboratory. Manley had previously been with the laboratory but left in 1951 to become professor and executive officer of the department of physics at the University of Washington.

GENE M. NORDBY has been appointed program director for engineering sciences at the National Science Foundation. He succeeds EDWARD E. LITKENHOUS, who has returned to the faculty of Vanderbilt University. Before joining the foundation a year ago as an engineer, Nordby was a member of the civil engineering faculty at Purdue University and at the University of Colorado.

ROBERT N. FAIMAN, chairman of electrical engineering at North Dakota State College (Fargo), will also be with the NSF Engineering Sciences Program for the forthcoming year. He is on leave from his institution and will serve in the capacity of engineer.

ALVIN F. COBURN, for 3 years resident physician at Columbia–Presbyterian Medical Center, New York, has been appointed director of clinical investigation in the Laboratories for Pharmaceutical Development, Yonkers, N.Y. He is known for his role in the demonstration of the relationship between an antecedent beta hemolytic streptococcal respiratory infection and rheumatic fever.

HELEN E. ELLIOTT, former assistant director (clinical) at Central Islip (N.Y.) State Hospital, has been appointed deputy assistant commissioner in the New York Department of Mental Hygiene. She will serve as assistant to Henry Brill, assistant commissioner in charge of the Division of Research and Medical Services.

JOHN J. BLASKO, former commissioner of mental health for Connecticut, has been appointed chief of the Veterans Administration Psychiatry Division in the Psychiatry and Neurology Service, Washington, D.C. He succeeds STEWART T. GINSBERG, who left the Veterans Administration in May to become commissioner of Mental Health for Indiana.

W. E. HANFORD, formerly vice president of the M. W. Kellogg Company, has been appointed assistant to the president, research and development, at the Olin Mathieson Chemical Corporation, New York.

C. L. GAREY, formerly of the Arkansas Agricultural Experiment Station, has joined the staff of the Institute of Paper Chemistry at Appleton, Wis. A research associate, he will be engaged chiefly with the fundamental study of clays, their behavior in liquid suspensions and their use in paper coating.

KATHERINE DODD has been appointed distinguished professor of pediatrics in the University of Louisville School of Medicine. Dr. Dodd is retiring as chairman of the pediatrics department at the University of Arkansas, which she has served for the past 5 years. Previously she taught at the University of Cincinnati for 9 years and at Vanderbilt University for 18 years.

BYRON B. CLARK, for 10 years head of the department of pharmacology at Tufts University School of Medicine, has been appointed director of pharmacology in the Research Division of Mead Johnson and Company, Evansville, Ill.

THOMAS H. JOHNSON will resign as director of the research division of the U.S. Atomic Energy Commission on 1 Oct. to become manager of the research division of the Raytheon Manufacturing Company, Waltham, Mass.

## Recent Deaths

PETER BEASLEY, Bronxville, N.Y.; 67; aeronautical engineer; shared in the development of a one-man helicopter and other flying devices; 9 Aug.

PHILIP BUCKY, New York, N.Y.; 58; professor of mining at Columbia University and inventor of a device to determine the stress of gravitation beneath the surface of the earth; 8 Aug.

MARY CAMPBELL, Reedsville, Pa.; 81; educational, research, and administrative worker for organizations for the blind here and abroad; received Shotwell memorial award of the American Association of Workers for the Blind and the Migel medal of the American Foundation for the Blind; editor of *Outlook for the Blind*; 8 Aug.

PERCY W. CARR, Maplewood, N.J.; 60; former consulting engineer in New York; general manager of plastics division at Curtiss-Wright; 8 Aug.

MANDRED W. COMFORT, Rochester, Minn.; 62; specialist in diseases of the stomach and member of Mayo Clinic staff; professor at the Mayo Foundation; 7 Aug.

EARL E. EBY, West Orange, N.Y.; 71; electrical engineer and retired manager of the power and equipment division of General Motors Overseas Division; inventor; 8 Aug.

MICHAEL FEKETE, Rehavia, Israel; 71; for 27 years professor of mathematics at Hebrew University's Institute of Mathematics, of which he was a former chairman; also had served as dean of the university's faculty of science; taught for many years at the University of Budapest; 13 May.

JOHN H. McFARLANE, Cranford, N.J.; 59; for 40 years a petroleum engineer for Charles Martin and Company; 10 Aug.

HOYT MILLER, Great Neck, L.I.; 74; chemist and for many years a vice president and director of the New York Times Company; 7 Aug.

RUSSELL C. MILLER, Easton, Pa.; 67; retired mathematics teacher at Polytechnic Preparatory School, Brooklyn; 11 Aug.

FREDERICK G. NOVY, Ann Arbor, Mich.; 92; dean of the University of Michigan Medical School; contributed to the growth of bacteriology as a discipline; established first antirabies station in the United States; first to demonstrate anaphylotoxin, later recognized as histamine; 8 Aug.

RAYMOND R. PATY, Knoxville, Tenn.; 61; one of the two members of the three-man board of directors for the Tennessee Valley Authority who opposed the Dixon-Yates contract; former president of University of Alabama and chancellor of the University System of Georgia; 7 Aug.

OTTO SCHROETER, Waterford, Conn.; 76; engineer and entomologist who worked on the Panama Canal; since retirement, a breeder of moths for research purposes; 12 Aug.

ALEXANDER P. SCHORSCH, Chicago, Ill.; 75; experimental psychologist and dean emeritus of the Graduate School of DePaul University (1928–52); 10 Aug.

ROSE TRAINOR, Troy, N.Y.; 71; retired director of sales and publicity for the division of the blind in the Massachusetts Department of Education; pioneer in teaching the blind who organized and taught classes for servicemen blinded in World War I; author of several textbooks for the blind and former member of the staff of the Boston School of Occupational Therapy; 10 Aug.

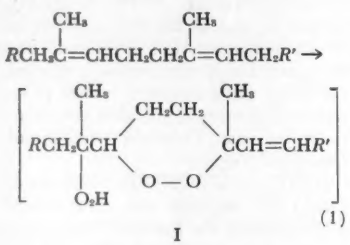
LAZARUS TROMMER, Queens, N.Y.; 69; retired civil engineer and author; designed various sections of New York's subway and elevated system; 8 Aug.

HEINRICH WIELAND, Munich, Germany; 90; won Nobel prize for research with cholic acids and development of Lobelin, a breathing stimulant; 1925–52, professor of chemistry and director of the chemical laboratory at the University of Munich; member of U.S. National Academy of Sciences and recipient of France's Lavoisier medal; 5 Aug.

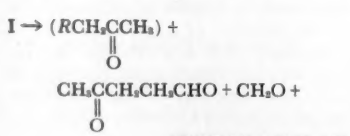
# Reports

## End Groups of Oxidized Rubber

Chain scission during the oxidation of polymeric 1,5-dimethyl-1,5-dienes occurs nearly quantitatively through the scission of an unusual peroxidic intermediate (*1*), followed ultimately by evolution of a group of fragments of low molecular weight at each scission (*1–4*). The composition of this group depends on the reaction conditions. The first known stable intermediates to be formed subsequent to scission are levulinaldehyde and formaldehyde (*4*):



I (1)



(2)

Bolland's kinetic (*5*) and analytic (*6*) studies combined with the requirements of the observed stoichiometry of scission form the basis on which it is possible to write a detailed mechanism (*1*) for the transformation represented by Eq. 1. Nothing is known in detail of the sequence of reactions resulting in Eq. 2. It has been suggested (*7*) that scission is associated with propagation rather than initiation—that is, with decomposition of a peroxy radical rather than of a hydroperoxide as is indicated in this scheme. This is still a moot point. It is now known, for example, that over-all scission efficiency is strongly determined by temperature (*1, 3, 8*) and that benzothiazolethione (*9*) and *o,o'*-dibenzamidodiphenyldisulfide (*10*) both accelerate oxygen consumption as well as scission, in contrast to earlier belief.

Assignment of the end groups on the newly formed chain ends (in parentheses in the equations) in the original outline of this mechanism (*1, 2*) was based on Naylor's (*11*) analyses of samples of a commercial oxidized rubber. It is assumed that the initial scission of a carbon-to-carbon bond occurs between the two adjacent atoms each attached to oxygen, with the formation of a methyl ketone as one new chain end. This is followed by opening of the six-membered heterocycle and subsequent evolution of the two aldehydes. The chain end remaining has been presumed to go rapidly through the stages $R$CHO → $R$CO$_2$H. The high oxygen content of Naylor's samples indicates that they were oxidized at relatively low temperature (*3, 8*), where over-all scission efficiency is low. Although "depolymerized" rubber of both low molecular weight and low oxygen content is available commercially, it seemed desirable to attempt to confirm directly the formation of the postulated end groups on samples oxidized under controlled conditions and not so severely "degraded."

The results of estimates of acetyl and carboxyl end groups on a group of similar samples adjusted in molecular weight in the range $10^5$ to $10^6$ by oxidation at high temperature are presented in Figs. 1 and 2 (*12*).

Analyses were made on samples of a relatively pure rubber obtained from a commercial latex concentrated by creaming. The only further treatment consisted of leaching the samples with hot water (95° to 99°C) after they had been coagulated on forms. The samples were treated with oxygen at 140°C in an apparatus which has been described (*4*). In this apparatus, the rubber is exposed to a flowing stream of gas so that volatile products are swept away. Under the conditions of this experiment, the measured scission efficiency (moles of chain cuts per mole of oxygen absorbed) is close to 0.1.

An unsuccessful effort was made to estimate total carbonyl content of the oxidized rubber by adaptation of a published method claimed to give high sensitivity and precision (*13*). The iodoform reaction (*14*), which should be specific for one end group, proved to be unexpectedly easy to use. By making use of an observation by Fuson (*15*) the reaction was carried out on a solution of rubber in a mixture of chloroform and dioxane. Rubber was precipitated by the addition of methanol, and iodoform was determined in the supernatant by comparison of the absorption at 347 mμ with a solvent blank. In Fig. 1 the results are plotted as methyl ketone end groups versus oxygen absorbed. The solid line is that expected if one $CH_3CO$ group is formed per scission.

Carboxyl groups were estimated by titration of 0.5- to 1.0-g samples of rubber with potassium methoxide in benzene solution, using phenolphthalein as indicator. The results for one series of samples are plotted in Fig. 2.

These results are in agreement with the hypothesis that the methyl ketone end groups are formed in the initial scission reaction and that the final structure of the other end group produced is determined by secondary reactions. Un-

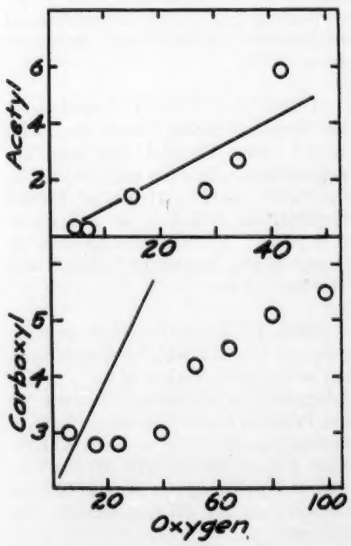



Fig. 1. (Top) Methyl ketone. Fig. 2. (Bottom) Carboxyl. Both are given as a function of oxygen consumed. Units are moles (equivalents) per $10^6$ g of rubber. Solid lines show the expected relations if one such end group is formed per scission.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

der the conditions used in the experiments reported here, just under half the product is oxidized as far as carboxylic acid (*16*).

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16. I am indebted to C. L. Hilton and O. E. Beckvold for spectrographic analyses, and to B. E. Jacobs, A. Denice, and J. Luethy for microtitrations.

29 May 1957

## Inhibition of Cell Division of Escherichia coli by Low Doses of Ultraviolet Light

Several workers have observed and worked with the division inhibition of *Escherichia coli B* by ultraviolet light (*1, 2*). However, little quantitative work has been done on the division inhibition as measured microscopically. Ultraviolet light inhibits the cellular division and causes the cells to grow into long "filaments," or "snakes," of about the same diameter as the normal cells but of many times the normal length. The filaments, as they will be called in this report, have no constrictions and appear as long, continuous structures under a phase-contrast microscope.

Cultures of *Escherichia coli B*, carried on nutrient agar slants, were inoculated into C-1 minimal medium (*3*) and grown overnight at 37°C with aeration. By morning, the cells were adapted to growth in the minimal medium and were growing exponentially at a concentration of about $10^9$ cells per milliliter. These were diluted to about $10^8$ cells per milliliter into fresh C-1 medium and grown to a concentration of about $2 \times 10^8$ cells per milliliter. These cultures were then transferred to quartz cuvettes, kept at 37°C, and stirred during the subsequent irradiation. Irradiation was done with a water-prism ultraviolet monochromator at the desired wavelength. Incident intensities were measured with a calibrated photocell, and the average intensity through the sample was obtained by the method of Morowitz (*4*). Irradiation times were of the order of 10 to 100 seconds, and reciprocity held over a factor of at least 25 in intensity. Following irradiation, the cultures were grown at 37°C in C-1 medium in subdued light for the desired time.

For doses up to about 100 erg/mm² at 2652 A, the rate of total mass increase of the irradiated cultures as determined by the turbidity at 650 mμ was indistinguishable from the rate of increase of unirradiated cultures. Microscopic observation and Petroff-Hauser counts of the irradiated cells during growth indicated that there were two important classes of cells: (i) those that continued to divide and grow at the usual rate, and (ii) those which increased in length but did not undergo division. During growth after irradiation, the normally dividing cells increased in number according to the division rate. The nondividing cells increased in length, so they were easily distinguishable from the normal cells. By phase microscopy, the relative number of normal cells and filaments was then determined. Knowing the factor by which the normal cells had increased since irradiation, the ratio of dividing cells to nondividing cells could be calculated for the culture as it existed immediately after irradiation.

This microscopic technique does not have the complications that arise in the determination of colony-forming ability, which is highly sensitive to the plating conditions. The cells are irradiated at 37°C during growth in the log phase with no significant interruption of growth conditions before, during, or after irradiation. The only stress being imposed on the system is the action of the ultraviolet light.

The logarithm of the survival of the ability to divide, determined as outlined, is proportional to the ultraviolet dose down to about 10-percent survival, as is shown in Fig. 1. An ultraviolet cross section for the ability to divide can thereby be found from the relation, $N/N_0 = e^{-\sigma D}$, where $N/N_0$ is the division survival ratio, $D$ is the dose of ultraviolet, and $\sigma$ is the sensitivity parameter called the cross section for division inhibition.

The ultraviolet doses to inhibit the division in this strain of *E. coli* relative to those needed to alter appreciably other metabolic processes in the same strain have been determined. These results, also shown in Fig. 1, are for random, nonsynchronized cultures. Irradiations were done at 2652 A on C-1 cultures at 37°C.

For determination of ribonucleic acid (RNA) and deoxyribonucleic acid (DNA), the cells were extracted with 70 percent ethanol and hot ethanol-ether to remove lipid material, cold 5 percent trichloroacetic acid to remove acid-soluble small compounds, and then hot trichloroacetic acid (5 percent) to remove the RNA and DNA. The hot trichloroacetic acid fraction was assayed for RNA by the orcinol reaction (*5*) and for DNA by the Keck modification of the Ceriotti reaction (*6*).

The doses which inhibit the microscopically observable division of almost all the cells have no detectable effect on the rate of DNA and RNA synthesis. Thus, the DNA and RNA content of the filaments is the same per unit cell mass as for the normally dividing cells. With

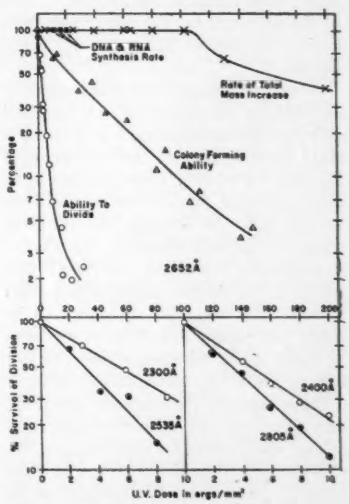


Fig. 1. (Top) Curves of log survival ratio for the given cellular property versus incident ultraviolet dose: ○, ability to divide within 3 hours in C-1 medium during continuous growth after irradiation; △, colony-forming ability on nutrient agar (plating done at about 23°C within 1 hour after irradiation; dilution series done in ice cold C-1 medium without glucose; 37°C incubation); ×, ratio of the rate of turbidity increase after irradiation to the rate for unirradiated samples; ■, ratio of the rate of RNA and DNA increase in irradiated to that in controls (this ratio is 1.00 to within experimental error of 5 to 10 percent for at least 2 hours after irradiation). (Bottom) Microscopically determined survival curves for the division versus ultraviolet dose at several wavelengths. These curves have been corrected to account for the spontaneously arising filaments in unirradiated cultures.

much higher doses of ultraviolet, Kelner (*7*), and Kanazir and Errera (*8*) found DNA synthesis to be inhibited.

Even though the cells do not divide within at least 3 hours after irradiation when grown at 37°C in the C-1 medium, most of them apparently recover their ability to divide at a later time and give rise to a normal macroscopic colony.

Further results relating to division inhibition mechanism follow. (i) The action spectrum for division inhibition, for which some data are shown in the lower part of Fig. 1, has a maximum at 2652 A and a minimum at 2300 A. (ii) As is shown by the work of Errera (*2*), the division inhibition can be reversed by visible light if the light is given within 15 minutes after the ultraviolet. (iii) The procedure of Robinow (*9*) for staining cytoplasmic cell boundaries discloses dark-staining bands at intervals along the filament of about the same distance as the length of normal cells. In old filament cultures, fission was occasionally seen at the dark-staining regions. Microscopic observation of the manner of lysis of the filaments by T-1 phage also indicates some sort of transverse cell boundaries.

Some preliminary work has been done on division inhibition in synchronized cultures. Synchronization was done by a slight modification of the technique of McNair Scott (*10*). There appears to be some variation in ultraviolet sensitivity as the cells go through the different stages of division. However, the change in sensitivity is probably not over a factor of 2. No definite correlation of this change with steps of division can be made yet, except that division seems to be more easily inhibited either just before or just after cytoplasmic division.

Since most of the filaments described here give rise to a normal-appearing colony when plated on nutrient agar, the effect measured by the microscopic technique is more correctly described as an extended division delay rather than a permanent inhibition. The colony formation is thus a result of a recovery of the ability to divide superimposed upon the original inhibition. The extent of recovery depends on the plating conditions. The initial inhibition seems to be very specific, and DNA, RNA, and protein synthesis continues at the usual rate (*11*).

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* U.S. Public Health Service predoctoral research fellow, 1955–57.

29 May 1957

## Respiratory Competence in the Diagnosis of Gene-Controlled Phenotypes in Saccharomyces

Respiratory deficiency (*1–6*) in yeast diminishes the phenotypic expression of many genes controlling the synthesis of enzymes. Comparison of the gene-controlled, adaptive fermentation of different sugars by respiration-deficient (aer) and respiration-sufficient (AER) strains indicates a slowed or delayed expression of fermentative ability. Studies of the adaptation of yeast to galactose in defined atmospheres suggest dependence of the rate of adaptation on the availability of oxygen. Thus, both a functioning respiratory mechanism and aerobic conditions are implicated in the rapid synthesis of enzymes. Respiration-deficient yeasts grow slowly on the surface of complete nutrient agar containing 2 percent of glucose and even more slowly on synthetic nutrient agar. When respiration-deficient strains carrying the appropriate dominant genes for fermentative ability are tested by replica plating or streaking on a synthetic medium for ability to ferment melezitose or galactose, or to synthesize adenine, they often resemble cultures carrying the recessive gene when they are scored after the usual period of from 1 to 2 days required for the respiration-sufficient dominant strain to form confluent growth. An example of the effect of respiratory competence on the diagnosis of phenotypes follows.

A hybrid (15177-uv4 × 8256) was made between two cultures, both of which were apparent nonfermenters of melezitose (one had been obtained by ultraviolet irradiation). The diploid hybrid was a rapid fermenter of melezitose, capable of rapid growth on solid synthetic medium or in broth tubes containing melezitose. This phenomenon might have been the result of the synergistic effect of two pairs of complementary genes controlling melezitose fermentation. Four tetrads segregated 2 AER melezitose-fermenters : 2 AER melezitose-nonfermenters. Further tests showed that the apparent nonfermenter parent (15177-uv4) was respiration-deficient, carrying the dominant gene controlling melezitose fermentation, while the other (8256) was respiration-sufficient, carrying the recessive allele for melezitose fermentation. It is clear that synergistic or complementary melezitose genes were not involved. Only a single pair of genes (*7*) controlling melezitose fermentation was concerned, the diminished fermentative ability of one parent being under cytoplasmic control. The types of progeny from the hybrid depend on whether or not the respiratory deficiency is under cytoplasmic or genic control (*8*). The effect of respiratory damage in obscuring the genotype of cultures is particularly significant, since many biochemical mutants used in genetic studies are derived from ultraviolet radiation, which is an inducer of respiratory deficiency in yeast (*9*).

It is reasonable to suppose that many different kinds of defects, both in genes and in cytoplasmic granules, may lead to respiratory deficiency. It is possible that (in addition to *bona fide* recessives) defects expressed by the slowing of adaptation to galactose- or maltose-fermentation which segregate regularly may be attributable to gene-controlled respiratory defects. This is especially true of delays in Durham-tube fermentation involving periods of less than 5 days (*10*) (Table 1). Delays of more than 5 days often involve mutation and selection. Reports of isomeric genes con-

Table 1. The effect of differences in respiratory ability of fermenters (GA) and nonfermenters of galactose (ga). AER signifies the phenotype for respiratory sufficiency; aer signifies the phenotype for respiratory deficiency. GA and ga indicate genotype. Plus sign denotes rapid growth of cells and gas evolution in inserts of Durham tubes and confluent growth of cells when streaked on the surface of agar. Minus sign denotes no appreciable growth and a lack of gas evolution in inserts of Durham tubes and no appreciable growth of cells streaked on the surface of agar. Mutant colonies usually are detected at frequencies of from $10^{-8}$ and $10^{-10}$ nonfermenter cells plated.

| Genotype | Respiratory phenotype | Galactose Durham tube | | Galactose agar streak | |
|---|---|---|---|---|---|
| | | 2 days | 4 days | 2 days | 6 days |
| GA | AER | + | + | + | + |
| ga | AER | − | − | − | Mutant colonies |
| GA | aer | −/+ | + | − | + |
| ga | aer | − | − | − | Mutant colonies |

Table 2. Genotype and phenotype of adenine-requiring yeasts. AD and ad signify genes controlling adenine synthesis. AER and aer signify respiratory phenotype.

| Genotype | Respiratory phenotype | Synthetic adenineless media | |
|---|---|---|---|
| | | Agar 2 days | Broth 2 days |
| AD | AER | + | + |
| AD | aer | − or +/− | + |
| ad | AER | − | − |
| ad | aer | − | − |

trolling the rates of carbohydrate fermentation in yeasts should be clarified by tests of the competence of the respiratory mechanisms of the segregants involved.

Similar complications are involved in the diagnosis of phenotype and genotype in adenine-requiring (ad) yeasts. The pinkish-red pigmentation of these yeasts is controlled by (i) genes, (ii) extrachromosomal factors, and (iii) environment (*11*). Both pink and brownish cultures give rise to adenine-requiring white colonies spontaneously, with relatively high frequencies. The pink color is restored on outcross to normal, and genetic tests revealed that gene mutation was not involved in the spontaneous change from red to white. In the absence of contact with air, such cultures form little or no pigment. Certain adenine-requiring, respiration-deficient pigmented strains form white colonies on 0.1 percent glucose agar (*12*), brownish colonies on 2 percent glucose agar, and deep red colonies on 8 percent glucose agar. Other nutritional factors (the concentration of yeast extract) influence color. In several strains, adenine-requiring, respiration-deficient clones can be distinguished from adenine-requiring, respiration-sufficient clones on 2 percent agar, on which the former are brown, while the latter are pink (*13*).

For some unknown reason, the phenotype of adenine-independent (AD), respiration-deficient yeasts is different in synthetic broth and on synthetic agar (Table 2) when scored over the usual period of from 1 to 2 days. Such cultures do not develop the positive phenotype (confluent growth) on adenineless synthetic agar plates, although they are phenotypically adenine-independent (show rapid growth) in broth. If an adenine-independent, respiration-deficient culture is diagnosed erroneously as adenine-dependent (because of the phenotype on agar), the vigorous growth which the hybrid with an adenine-dependent AER culture (AD aer × ad AER) displays on agar might be interpreted incorrectly to indicate the presence of two nonallelic genes controlling adenine-synthesis.

In certain matings (*8*) between (i) adenine-dependent mutants of strain 8256 which had been altered from pink to brown by ultraviolet irradiation and (ii) adenine-dependent mutants of strain 8282 which had changed spontaneously from pink to brown, the hybrid was pink—that is, brown × brown produced pink—suggesting the presence of nonallelic, synergistically acting genes. Subsequent crosses showed that the brown parents were both respiration-deficient and that the hybrid was respiration-sufficient. In 14 tetrads from three such hybrids, segregation was 2 ad AER pink: 2 ad aer brown. Tetrad analysis showed that respiratory competence was under genic control in one parent and cytoplasmic control in the other, and that the "nonallelism" was attributable to the restoration of respiratory competence in the hybrid by the complementary action of gene and cytoplasm.

A few respiration-deficient progeny may be expected from any AER × AER hybrid. For example, 31 tetrads from such a mating yielded the following:

| | | | | |
|---|---|---|---|---|
| AER | AER | AER | AER | 22 |
| AER | AER | AER | aer | 2 |
| AER | aer | aer | aer | 2 |
| aer | aer | aer | aer | 5 |

It may be inferred that the respiratory granules are often lost during the process of cutting out the spore plasm from the epiplasm.

In view of these results, a fundamental ambiguity prevails in certain genetical analyses of the inheritance of slow fermentation, adenine-synthesis, and pigmentation. This ambiguity arises from the absence of information concerning the respiratory competence of hybrids and segregants. Routine tests of segregants for their respiratory phenotypes are an essential complement to any genetical analysis, regardless of the respiratory competence of the parents.

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**References and Notes**

1. A number of experimental criteria have been employed in the diagnosis of respiration deficiency (*2*). In our laboratory a respiration-sufficient (AER) strain is defined operationally in terms of (i) $Q_{O_2}(N)$ about 1000 with glucose as substrate; (ii) growth on lactate agar (*3*); (iii) intensely colored colonies after overlay with 2,3,5-triphenyl tetrazolium chloride (TTC) (*4*); and (iv) alkali production in an acetate medium (*5*). A respiration-deficient (aer) strain is defined operationally in terms of (i) $Q_{O_2}(N)$ 0–50 with glucose as substrate; (ii) inability to grow on lactate agar (*3*); (iii) uncolored or faintly colored colonies after overlay with TTC (*4*); and (iv) no alkali production in an acetate medium (*5*).
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21 June 1957

## "Lethal" Variant of Candida albicans, a "Petite Colonie" Mutant

Two spontaneous and irreversible hereditary variants may be easily distinguished in the pathogenic yeast *Candida albicans* (*1*). The colonies of the normal (wild) form, strain 582, are smooth and are built up by typical yeast cells ("Y" form). One variant, strain 806, gives wrinkled, hard, rough colonies, and, microscopically, it is filamentous or mycelial ("M" form or variant). The second variant was called "lethal," and it is characterized by smaller sized colonies that perish rather rapidly.

Nickerson carried out studies with strains 582 ("Y" form) and 806 ("M" variant), and, in a recent paper, Nickerson and Falcone (*2*) state that the "M" variant is deficient in a protein-disulfide reductase that is apparently essential for cell division but not for growth.

We have studied the biochemical behavior of the "lethal" variant (strain 807), and our results show that the respiration of the mutant is nearly abolished. In manometric studies in a Warburg apparatus (yeast, 4 mg; buffer, 0.05*M* $KH_2PO_4$; substrate, 100μ*M* glucose; temperature, 30°C; atmosphere, air or $N_2$) the normal form gave: $Q_{CO_2}{}^{N_2} = 13.2$ (μl/mg of yeast per 10 minutes); $Q_{CO_2}{}^{air} = 8.9$; $Q_{O_2}{}^{air} = 6.8$; respiratory quotient = 1.3; and Pasteur effect = 33 percent (inhibition). On the other hand, the following results were obtained with the "lethal" variant: $Q_{CO_2}{}^{N_2} = 12.4$; $Q_{CO_2}{}^{air} = 12.5$; $Q_{O_2}{}^{air} = 0.24$; respiratory quotient = 53; and Pasteur effect = 1.6 percent (inhibition).

Cytochrome-*a* and -*b* bands were absent from the absorption spectrum of the "lethal" mutant. These bands were present in the spectrum of the normal form. The α and β bands of cytochrome *c* were

present in the spectra of both the normal and the "lethal" forms.

Our results demonstrate that the "lethal" variant of *Candida albicans* and the "petite colonie" mutant of *Saccharomyces cerevisiae* described by Ephrussi (*3*) have the same physiological impairment. This fact suggests that the hereditary loss of the respiratory function may be a frequent phenomenon among microorganisms endowed with both aerobic and anaerobic metabolism.

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27 May 1957

## O-Methylation of Epinephrine and Other Catechols in vitro and in vivo

For the past 20 years the catechol amines, epinephrine and norepinephrine, have been considered to be transformed in the body, mainly by monoamine oxidase. However, recent investigations have shown that these amines may be inactivated by enzymes other than monoamine oxidase (*1*). The important observation of Armstrong and McMillan (*2*), that a major metabolic product of epinephrine and norepinephrine is 3-methoxy-4-hydroxy mandelic acid, suggested that methoxy derivatives of the catechol amines may be the precursors of the deaminated compound. I wish to report the isolation of an enzyme from rat liver which catalyzes the O-methylation of epinephrine and other catechols. In addition, the presence of methoxy epinephrine and methoxy norepinephrine in the urine was demonstrated.

Table 1. Enzymatic O-methylation of epinephrine. The soluble supernatant fraction from 10 mg of rat liver was incubated at 37°C with 0.1 μmole of l-epinephrine bitartrate, 50 μmole of phosphate buffer (*p*H 7.4), 20 μmole of $MgCl_2$, and water to make a final volume of 0.5 ml. After 30 minutes of incubation, the reaction mixture was assayed for epinephrine (*13*).

| Additions | l-Epinephrine metabolized (μmole) |
|---|---|
| None | 0.000 |
| S-Adenosylmethionine, 0.05 μmole (*8*) | 0.041 |
| S-Adenosylmethionine, 0.1 μmole | 0.065 |

Enzymes have been found which transfer the methyl group of S-adenosylmethionine to the nitrogen of nicotinamide (*3*) and guanidoacetic acid (*4*). These findings suggested the possibility that phenols also could accept methyl groups by a similar mechanism. Incubation of the soluble supernatant fraction of rat liver with epinephrine, adenosine triphosphate, and methionine resulted in the disappearance of the cathechol amine. In the absence of either cofactor, no metabolism took place. Cantoni has shown that an enzyme in the liver can form S-adenosylmethionine from adenosine triphosphate and methionine (*5*). When S-adenosylmethionine was substituted for adenosine triphosphate and methionine, a more rapid disappearance of epinephrine was observed (Table 1). The metabolic product was extracted into an ether-isoamyl alcohol mixture at *p*H 9.0 and was then returned to dilute hydrochloric acid. The acid extract contained a phenolic compound which did not give a reaction for catechols (*6*). These observations were taken as evidence that an enzyme present in rat liver can transfer the methyl group of S-adenosylmethionine to one of the phenolic groups of epinephrine.

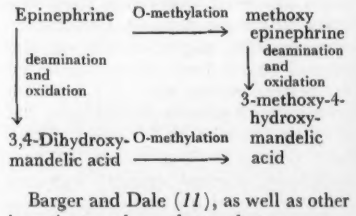
Several other catechols (norepinephrine, 3,4-dihydroxyphenylethylamine, and 3,4-dihydroxybenzoic acid) also served as substrates for the enzyme. The enzyme has been purified 20-fold and is stimulated considerably by magnesium ions. Supernatant fractions of brain, kidney, and spleen can also O-methylate epinephrine, but to a lesser extent than the liver.

Evidence for the identity of methoxy epinephrine formed by the enzyme was obtained by deaminating and oxidizing the metabolite with a monoamine oxidase preparation to yield 3-methoxy-4 hydroxymandelic acid as follows. Methoxy epinephrine was incubated with rat-liver mitochondria, and the metabolic product was extracted with ethyl acetate at *p*H 1, returned to a dilute sodium bicarbonate solution, and reextracted into ethyl acetaté at *p*H 1. The resulting compound, when subjected to paper chromatography with several solvent systems (*7*), had the same $R_f$ values and color reaction as an authentic sample of 3-methoxy-4-hydroxymandelic acid (*8*). A marked depression in the formation of the deaminated derivative was observed when the mitochondrial preparation was obtained from a rat that had been pretreated with iproniazid, an inhibitor of monoamine oxidase.

Urine of rats was examined for methoxy epinephrine after incubation with β-glucuronidase. Phenolic amines were extracted from a sodium chloride-saturated urine at *p*H 9.0 into an ether-isoamyl alcohol mixture and returned to dilute hydrochloric acid. The acid extract was saturated with sodium chloride, adjusted to *p*H 9.0, and shaken with *n*-butanol. After the butanol extract was evaporated to dryness, the residue was dissolved in a small volume of an ether-methanol mixture and subjected to two-dimensional chromatography (solvent systems I and III). A compound was found that had the same $R_f$ values (0.70 and 0.52) and color reaction as the enzymatically formed methoxy epinephrine. The amount of methoxy epinephrine excreted in the urine of rats was markedly elevated after the intraperitoneal administration of iproniazid and l-epinephrine bitartrate (*9*).

Rat urine was also examined for methoxy norepinephrine after the intraperitoneal administration of l-norepinephrine bitartrate. Urine was incubated with β-glucuronidase and extracted as described in the preceding paragraph. After the extract had been subjected to two-dimensional chromatography (solvent systems I and III), a compound was found that had the same $R_f$ values (0.54 and 0.43) and color reaction as enzymatically formed methoxy norepinephrine (*10*).

On the basis of the experiment described, the following scheme for the metabolism of epinephrine and its congeners is suggested:




Barger and Dale (*11*), as well as other investigators, have shown that numerous derivatives of epinephrine have sympathomimetic action. It is conceivable that some of the activity of the catechol amines could be mediated through their methoxy transformation products (*12*).

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9. Enzymatically formed methoxy epinephrine and the metabolite isolated from the urine after the administration of l-epinephrine bitartrate had the same $R_f$, fluorescent spectrum, and partition coefficients as a synthetic sample of 3 methoxy-4-hydroxyphenyl-2-methylaminoethanol (synthesized by S. Senoh and B. Witkop, National Institutes of Health).
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26 July 1957

## Isolation of Cytopathogenic Viral Agent from Feces of Cattle

In the early part of September 1956, 19 beef calves, 3 to 4 months of age, were purchased and brought into an experimental barn unit. Approximately 10 days later the calves developed temperatures varying from 104° to 106°F, and several also had a slight cough and some nasal exudate. The calves were treated with broad-spectrum antibiotics and recovered uneventfully.

Two pregnant cows were brought into the same barn unit on 7 October. These cows developed fever and nasal exudate within a week. One cow recovered in a few days but aborted approximately 1 month later. The other cow developed pulmonary complications and was treated with broad-spectrum antibiotics over a period of 21 days. When it was examined 2 to 3 months later, this cow was not pregnant. The aborted 7-month-old fetus and both cows were found to be negative for evidence of infection caused by *Vibrio fetus, Leptospira pomona,* and *Brucella abortus* (*1*).

On 5 January 1957, nine beef calves, 3 to 6 months old, were purchased and housed in a separate pen in the aforementioned experimental barn unit. Within a week several of these calves developed temperatures varying from 104° to 106°F, slight cough, moderate nasal exudate, and considerable mucus in the stools. These animals maintained normal food intake and recovered without treatment in approximately 1 week.

A viral agent, cytopathic for bovine kidney cells grown *in vitro,* was recovered from (i) fecal samples collected from four of the latter calves during the late stages of the illness and also 3 months after recovery; (ii) a pool of fecal samples collected 15 February 1957 from the two cows, one of which aborted; (iii) samples of ascites fluid, stomach fluid, and placental fluid collected from the aborted fetus; and (iv) a pool of fecal samples from calves in another experimental unit which had fever and slight nasal exudate.

Ten pooled fecal samples collected from calves and cows with no history of illness were found free from this virus as judged by the absence of cytopathic changes in inoculated tissue cultures.

Tissue cultures of bovine kidney (*2*) were prepared in tubes of the trypsin digest method described by Youngner (*3*). The cells were grown in a nutrient medium consisting of Hank's solution with 0.5 percent lactalbumin hydrolyzate and 10 percent bovine serum. When cell sheets were formed on the glass surface, this nutrient medium was withdrawn and replaced with a maintenance medium consisting of Hank's solution containing 0.5 percent lactalbumin hydrolyzate but no serum. To both media were added 100 units of penicillin, 200 μg of streptomycin, and 100 units of mycostatin (*4*) per milliliter.

Fecal samples were suspended in phosphate-buffered saline containing 500 units of penicillin and 500 μg of streptomycin per milliliter. These suspensions were strained through a four-layer pad of cheesecloth into stainless-steel tubes which were centrifuged at 10,000 rev/min for 30 minutes in a refrigerated centrifuge. Each supernatant was subsequently diluted 1/2 with maintenance medium and dispensed in quantities of 1 ml to each of five tissue-culture tubes. After 2 to 3 hours, this inoculum was withdrawn and replaced with fresh maintenance medium. The fetal fluids which were clear and free of bacteria were diluted 1/5 with maintenance medium and dispensed in quantities of 1 ml to each of five tissue-culture tubes.

Cytopathic changes characterized by focal rounding and shrinking of cells were observed in the bovine kidney cell cultures within 12 to 24 hours. These changes progressed until all cells were affected and fell off the glass surface after 24 to 96 hours (Fig. 1). The fluid of culture tubes in which the majority of cells were affected also was considerably more acid than the fluid of the unaffected control tubes.

Ten serial passages of infected cell culture fluids carried out have regularly resulted in cytopathic cell changes as well as in increased acidity of the culture fluids. The viral agents recovered from the different sources have behaved identically in these aspects.

Replicate titrations of various tissue culture passage levels showed a $TCID_{50}$ of $10^7$ to $10^{12}$ per milliliter. Cell cultures inoculated with the lowest dilution of infected fluids showed typical cytopathic changes as early as 4 hours after inoculation, while those inoculated with the highest dilution revealed such changes 36 to 42 hours after inoculation.

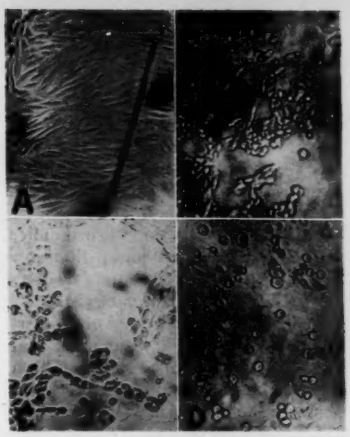

Fig. 1. Bovine kidney cells (about × 15). (*A*) Normal cells growing on the glass wall of a test tube. (*B*) Early cytopathic effect (1+) of virus growth; a number of cells have become shrunken or rounded, but most of the cell sheet appears normal. (*C*) Progression of virus-induced cytopathic changes (2 to 3+); a large number of cells are rounded or shrunken. (*D*) Final stage of cytopathic changes (4+); no normal cells remain, and most cells have fallen off the glass surface.

The increase in acidity at the time of severe or complete cell destruction varied from 0.2 to 0.4 *p*H units as compared with normal cell cultures. The viral agent replicates and produces cytopathic changes in bovine kidney cell cultures at *p*H 6.4 to 8.4. The cytopathic changes develop more slowly and seem less extensive at *p*H 6.4 to 6.6 than at *p*H 7.4 to 8.4. Considerable rounding and degeneration were observed in noninfected control cultures at *p*H 8.4.

The virus passes through a fine sintered glass filter without appreciable loss of titer. It will also pass an ultrafilter membrane (*5*) with average pore size of 0.05 to 0.08 μ, but not through a membrane with average pore size of 0.01 to 0.05 μ.

The virus, which is ether-resistant, survives storage in tissue-culture maintenance fluid (*p*H 7.6 to 7.8) at −10° to +22°C for at least 2 months, at 37°C for at least 120 hours, and at 56°C for at least 30 minutes.

Pooled preinfection and convalescent serums from the four calves, from whose feces virus was isolated, were tested for specific neutralizing antibodies against the virus. Tissue-culture neutralization tests were carried out in accordance with the method described by Paul and Melnick for paired poliomyelitis serums (*6*).

The preinfection serum pool failed to prevent cytopathic changes, while a 1/10 dilution of the convalescent serum pool prevented such changes (50 percent serum titer log = 1.4).

The virus causes neither signs of illness nor pathological tissue changes in normal suckling or weaned Swiss white mice when it is inoculated by the intraperitoneal or intranasal routes. However, the virus causes illness and extensive myocardial necrosis in weaned mice when it is inoculated intraperitoneally after 2 to 3 daily intramuscular doses (2.5 mg) of cortisone acetate (*7*).

The etiological significance of this particular virus in the disease manifestations in cattle described has not been established. The disease-producing capacities of the virus in various animal species will be evaluated experimentally. The possible serologic relationships between this viral agent and other cytopathogenic viral agents isolated from the alimentary tract will also be investigated—for example, infectious bovine rhinotracheitis virus (*8*), poliomyelitis virus (*6*), Coxsackie virus (*9*), ECHO viruses (*10*), ECBO viruses (*11*), and adenoviruses (*12*) (*13*).

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27 May 1957

## Decomposition of Actinomycin by a Soil Organism

Several studies indicate the importance of microorganisms in the inactivation of antibiotics, although few comprehensive studies have been attempted. The most extensive reports have dealt with the capability of many bacterial species to inactivate penicillin by the hydrolytic action of an enzyme, penicillinase (*1*). In addition, Pramer and Starkey (*2*) have reported the isolation from soil of a Gram-negative bacterium capable of decomposing streptomycin. Smith *et al.* (*3*) have observed that growing and resting cells of *Escherichia coli, Bacillus mycoides, Bacillus subtilis,* and *Proteus vulgaris* can degrade chloramphenicol by hydrolysis, reduction, oxidation, and cleavage of the molecule. Waksman and Woodruff (*4*), as a result of an investigation of the stability of actinomycin in fresh soil, suggested that inactivation of actinomycin under these conditions may be the result, in part, of the activities of soil microorganisms. The present report describes the isolation of an actinomycin-decomposing organism from soil and presents observations concerning the nature of, and the optimum conditions for, this reaction (*5*). An enzyme system, tentatively designated *actinomycinase,* appears to be involved in the degradation process.

Table 1. Influence of age of *Achromobacter* sp. on the decomposition of actinomycin D. *Achromobacter* sp. was cultivated in actinomycin medium; at various intervals, samples of the culture medium were harvested for cell counts, microbiological assays, and resting-cell studies. For the latter purpose, washed cells of the organism were suspended in 0.06*M* phosphate buffer, *p*H 7.5; the actinomycin-D concentration was 1000 μg/ml, temperature 28°C.

| Age of culture (hr) | Cell count (No./ml) | Percentage of actinomycin (500 μg/ml) remaining in culture medium | Percentage of actinomycin (1000 μg/ml) remaining after 6 hr incubation with resting cells |
|---|---|---|---|
| 0 | $1.5 \times 10^7$ | 100 | 100 |
| 8 | $7.9 \times 10^7$ | 100 | 100 |
| 16 | $2.0 \times 10^9$ | 100 | 100 |
| 20 | $2.1 \times 10^9$ | 70 | 90 |
| 24 | $1.9 \times 10^9$ | 52 | 50 |
| 28 | $1.8 \times 10^9$ | 24 | 33 |
| 32 | $1.2 \times 10^9$ | 0 | 0 |

The medium employed, consisting of mineral salts, 0.1 percent yeast extract, and actinomycin D, was a modification of one used by Pramer and Starkey (*2*). Microbiological assays of actinomycin in culture fluids were performed by disk diffusion (*6*) and streak dilution methods (*7*). Isolation of an actinomycin-decomposing organism was accomplished by enrichment of a barnyard soil and subsequent cultivation of samples of this soil in media containing actinomycin D. On the basis of morphological, staining, cultural, and biochemical characteristics, it was established that the responsible bacterium belonged to the genus *Achromobacter.*

Growing cells of the *Achromobacter* sp. readily decomposed approximately 560 μg of actinomycin D per milliliter of medium in shaken (24 hours) and static (64 hours) cultures under aerobic conditions. The organism degraded actinomycin D (500 μg/ml) through a *p*H range of 6.0 to 8.0, *p*H 7.5 being optimum (48 hours), and at temperatures between 20° and 37°C, 28°C being the most favorable temperature. The extent of decomposition was found to vary within the range of 85 to 4010 μg of actinomycin per milliliter of medium. Up to 1000 μg/ml was destroyed in 48 hours; decomposition of 4010 μg/ml required 84 hours.

A direct relationship was found to exist between inoculum size and the decomposition process. For example, if $7.4 \times 10^{10}$ cells were employed, decom-

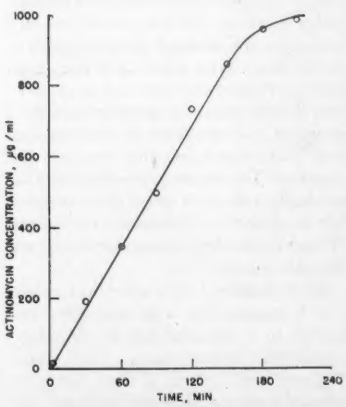


Fig. 1. The amount of Actinomysin D decomposed with time by a suspension of *Achromobacter* sp. cells. Cells were centrifuged out of actinomycin medium, washed twice with distilled water, and finally suspended in 0.06*M* phosphate buffer. One milliliter of this bacterial suspension was mixed with 1 ml of an actinomycin-D solution and 8 ml of 0.06*M* phosphate buffer, *p*H 7.5. Temperature of incubation was 28°C. Final concentration of actinomycin D was 1000 μg/ml.

position of 415 μg of actinomycin per milliliter occurred within 48 hours; if $7.4 \times 10^6$, within 72 hours; if $7.4 \times 10^2$, within 120 hours. In addition to actinomycin D, actinomycins B and C were also decomposed.

A study of the influence of various growth media on decomposition revealed that, as the growth medium became more complex in nature, the time required for actinomycin decomposition increased. The most rapid decomposition took place when actinomycin D was present as the sole organic compound. The decomposition of actinomycin in relation to the growth phase of the organism also was examined. Decomposition did not begin until quite late in the log or early in the stationary phase of growth, and complete decomposition did not take place until the cell population began to decline (Table 1). Further, it was observed that cells harvested during the lag or early log phase required 66 to 72 hours to degrade the drug in subculture, that cells obtained during the log phase required 48 to 54 hours, and that cells harvested late in the log or early in the stationary phase required 36 to 42 hours.

Resting cells of the organism, suspended in 0.06*M* phosphate buffer, rapidly (1 to 4 hours) decomposed actinomycin D over a wide concentration range (100 to 1400 μg/ml) (Fig. 1). The optimum *p*H for decomposition of actinomycin D was *p*H 7.5; the optimum temperature, 45°C. Destruction of actinomycin occurred with equal rapidity (2.5 hours) when cells were incubated under either static or shaken conditions. Whereas actinomycins B and D were completely decomposed under these conditions, only 60 percent of actinomycin C was destroyed within 6 hours. As in the case of growing cells, the age of the culture at time of harvest of the bacteria significantly affected decomposition by resting cells. Only cells harvested subsequent to the log phase of growth were able to decompose actinomycin (Table 1).

The data obtained thus far suggest that the destruction of actinomycin is enzymatic in nature. Nonspecific adsorption of the antibiotic by cells of the *Achromobacter* sp. does not appear to be involved, since only trace quantities of the drug can be detected after extraction of resting cells which have attacked actinomycin. Young cells of the organism, boiled cell preparations, growing cultures of *E. coli*, *Pr. vulgaris*, actinomycin-resistant *Micrococcus pyogenes* var. *aureus*, and *Penicillium notatum* all proved to be unable to adsorb or to attack the antibiotic. An acetone powder prepared from cells of the *Achromobacter* sp. readily decomposed actinomycin. Only the cells exhibit enzymatic activity; culture filtrates were found to be inactive.

Preliminary investigations have been carried out on the nature of the degradation products formed by the *Achromobacter* sp. from actinomycin D. Extraction of the decomposition products from culture fluids was accomplished through solvent extraction (acid-butanol). The residue obtained after distillation of the butanol in a vacuum was purified further through cellulose column chromatography; borate buffer (*p*H 8.2)—*n*-butanol and *n*-butyl ether—was employed as solvent system. The decomposition products separate on the column as two orange-red-colored bands, the slower-moving component representing 95 percent of the material. The colored bands were eluted separately from the column. After distillation, the residues were dissolved in warm ethyl acetate and precipitated with carbon disulfide.

Yields of the fast-moving component were low, but additional work was carried out with the slow-moving component. This component exhibited certain properties which differentiate it from the parent compound; for example, its behavior in circular paper chromatography, its visible and ultraviolet light absorption spectra, and its solubility in water and organic solvents differ from corresponding properties of actinomycin D. In contrast, qualitative amino acid analysis revealed the presence of the same amino acids in both the degradation product and actinomycin.

On the basis of these data, the degradation product does not appear to be similar to desaminoactinomycin or to actinomycin acid—compounds obtained by Brockmann and Franck (*8*) through chemical degradation of the actinomycin molecule. Further studies are in progress to purify and characterize the enzyme system responsible for actinomycin decomposition and to determine more completely the nature of the degradation products.

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26 April 1957

## Depths of Leaching in Glacial Deposits

The depth of leaching of carbonates in soils has been widely used for estimation or comparison of age of Pleistocene deposits in areas of temperate, humid climate. Leaching is influenced by many factors, such as time, climate, vegetation, surface topography, permeability and carbonate content of the material, and so forth. These factors have been discussed by several authors (*1*). C. S. Denny emphasized recently (*2*) that differences in depth of leaching may relate chiefly to the total amount of carbonates in the parent material of soil. However, he did not elaborate on this relationship in more detail.

The shallow depth of leaching in very calcareous or dolomitic materials may be explained by two principal factors: (i) A higher amount of carbonates requires a longer time of leaching, particularly if the carbonate fragments are coarse and if dolomite exceeds calcite in amount. (ii) The more carbonates that are present in the parent material, the thinner the resulting leached soil or profile of weathering will be, for the leached soil consists merely of the insoluble residues. A contrasting example may clarify this statement. If 10 ft of gravel, containing 10 percent carbonates, is leached, 10 percent of the volume will be lost by leaching, and the unleached residues will compact to 9 ft. If 10 ft of gravel with 90 percent carbonates is leached, the resulting thickness of the unleached residues will be merely 1 ft. Even if all other factors had been similar during the development of these two profiles of weathering, the great difference in the resulting measurable thickness (9 ft and 1 ft) does not mean that the 9-ft weathering profile is older than the one 1-ft deep. The opposite may be closer to a correct answer, since a longer time may be required for leaching of a 9 times larger volume of carbonates.

If the carbonate content varies only from 10 to 20 percent between individual places of measurement, the resulting differences in the depth of leaching may be in the usual range of variations which are observed even in one single exposure. Thus MacClintock (*3*) did not find any differences in depth of leaching in the region south of Utica, N.Y., where the percentage of carbonates ranged from 30 to 50 among pebbles.

Most authors do not report the amount of carbonates in the parent material at all. Therefore it is difficult to judge how much their measurements have been influenced by the compaction of the noncarbonate residues. Since the percentage of carbonates varies from zero to 95 in the glacial drifts of Ontario and probably to a considerable extent also in other areas, it is very difficult to com-

Table 1. Depth of leaching in selected areas. The italic numbers in parentheses in columns 1 and 3 indicate sources listed under "References and Notes." The italic numbers without parentheses in columns 3 and 4 indicate the most abundant thicknesses or depths.

| Location and description of material | Carbonates (%) | Measured depth of leaching (ft) | Calculated original thickness of leached portion (ft) |
|---|---|---|---|
| *I. Gravelly soils that began to form during Cary time* | | | |
| A Fanshawe, near London, Ont., pebbly gravel, probably of Lake Maumee time and thus about 14,000 yr old (*5*) | 80 | 0.5–*1*–*1.5*–3 | 2.5–*5*–*7.5*–15 |
| B Eastern North America (*6*) | 50–60 | *3.5*–*5* and 7 (*7*) | *7.5*–*11* and 16 |
| C Eastern North America (*6*) | 30–40 | 4–*5*–*6*–7 (*7*) | 6–*7*–*9*–11 |
| D Eastern North America (*6*) | 10 | 5–8 (*7*) | 5.5–9 |
| *II. Gravelly soils formed since the end of Cary time or since Mankato and Valders time* | | | |
| E Ridgetown, Ont., pebbly gravel, submerged Lake Whittlesey bar, younger than 12,660 ± 440 yr (*8*) | 45 | 1–*1.3*–2–3.5 | 2–*2.5*–*3.5*–6.5 |
| F Union, Ont., Lake Warren beach barrier (*9*); 9600 to 12,000 yr old (*5*) | 50 | 1.3–2 | 2.5–*4* |
| G Orillia, Ont., Lake Algonquin beach (*10*); 8000 to 9000 yr old (*5*) | 70 | 1–*1.3*–2.5 | 3.5–*4.5*–8.5 |
| *III. Soils in clayey till; began to form during Cary time* | | | |
| H Between London, Ont., and Mitchell moraine | 50–60 | Mostly *1.7* | *4* |
| I Mitchell moraine at Elginfield, Ont., very stony till with 30 percent clay; 90 percent carbonates among pebbles | 65 | *1* | *3* |
| J Northern Ohio, late Cary, according to G. W. White (*11*) | 14 | Mostly 2.7 (*11*) | *3.2* |

pare the measurements of leaching without introducing a correction factor. Such a correction factor for calculation of the original thickness of weathering profiles in calcareous and dolomitic weathering profiles is suggested in this report (*4*).

Some actual examples with several measurements in each area are selected from Ontario and other neighboring regions where the soil formation began during the Cary subage or slightly later. They are arranged in Table 1 in groups of similar age, texture of the material, and topography, in order to avoid the influence of variables other than the carbonate content.

The original thickness of the leached layer is calculated by using the following formula:

$$h = \frac{100d}{n}$$

where $h$ is the original thickness of the leached layer, $d$ is the measured thickness of the leached weathering profile, and $n$ is the percentage of noncarbonates before leaching in the parent material.

Materials of groups I and II (see Table 1) have a similar texture (permeable gravel), and the orginal thickness of the leached weathering profile agrees well with their age differences (average above 5 ft in I and 4.5 ft or less in II). This difference is not conspicuous from actual measurements—for instance, in gravels A and E—because of the higher percentage of carbonates in the older soils at Fanshawe (A).

The measured depths of leaching vary in each of the groups I and III to such an extent that it would be difficult to assume that each group represents a unit of similar age and texture. These differences level out if the leached thickness of carbonates is added to the measured depth (see Table 1, last column).

The exceptionally shallow depth of leaching (12 in.) in the very stony till at Elginfield (I) indicates that leaching of large fragments has required a longer time, and therefore the depth is slightly less than in H, though both tills are clayey and of a similar age.

The relatively deeper leaching at Orillia (G) than at Ridgetown (E) may be explained by presence of dolomite in the gravel E, while G contains only limestone pebbles (all other Ontario samples of Table 1 contain dolomite, but less dolomite than limestone). Although differences in particle size of carbonates and calcite/dolomite ratios also affect the depth of leaching, the total amount of carbonates seems to be of a greater importance.

In order to facilitate comparison of depth of leaching while deciphering the Pleistocene stratigraphy, I suggest that the percentage of carbonates also be published with the other characteristics of the drift. If gravels are sandy, the percentage of carbonates is usually higher among pebbles than it is in the entire sample. Therefore both figures would be required. If the percentage of carbonates is higher than 20 or the measured depth of leaching is several feet, or both, the original thickness of the leached weathering profile should also be calculated, for this thickness indicates the age of soil better than the measured depth of leaching. For materials low in carbonate, this calculation may not be necessary.

If leaching has affected several layers of drift, the amount of carbonates may have been different in each of them—for example, in silt overlying gravel or till. In such cases a recalculation of the original thickness of the leached weathering profile is more difficult, requiring determination of the carbonate content of each layer.

The speed of leaching and the resulting depth of the leached profile is certainly influenced also by the particle size of carbonate fragments, their porosity, and whether they consist of calcite or dolomite. An insufficient number of contrasting cases does not permit me to introduce any correction factors for these variables at present, but studies of them are in progress.

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3 June 1957

## Infantile Experience and Resistance to Physiological Stress

It has been reported (*1*) that rats which had been "gentled" (that is, picked up and stroked once daily for 21 days postweaning) were heavier and reacted with less cardiovascular and gastrointestinal damage under conditions of immobilization for 48 hours than did the "nongentled" controls. In addition, adrenal glands of the nongentled were heavier than those of the gentled animals. Subsequent research (*2*) has revealed that rats handled prior to weaning showed significantly less mortality following 5 days of total food and water deprivation than did nonhandled rats or rats handled after weaning. The present experiment (*3*) was designed to investigate the response of rats, handled and nonhandled, in infancy (days 1 through 20) to physiological stress.

Twenty-seven male Sprague Dawley-Holtzman albino rats were handled from day 1 through day 20. Handling consisted of removing the pup from the nest, placing it in a 2.5- by 3.5- by 6-in. compartment, and then returning it to the nest. This procedure was followed once daily until weaning, on day 21. Twenty-nine rats were not handled in any manner through the first 20 days of life and then were handled only once, at weaning. The experimental treatments of handling and nonhandling were randomly assigned to complete litters. All rats within each litter received the same treatment.

All animals received no further handling until 70 days of age. At this time 20 rats from the handled group and 20 rats from the nonhandled group were given a 20-percent solution of glucose, injected intraperitoneally at a dosage of 7.5 ml/100 g of body weight, according to the method described by Brogi (*4*). A 21.4-percent mortality has been reported with this dosage for normal animals. Following the administration of the glucose, the animals were placed in individual cages without food or water. Twenty-four hours after the glucose injection the surviving animals were permitted to drink for 1 hour. The amount of water consumed was recorded. They were then sacrificed, and the left adrenal was removed and weighed. The remaining seven handled and nine nonhandled rats were not given the glucose injection but were sacrificed, and the adrenal weights were determined.

The mean body weight for the groups at weaning (21 days of age) was 47.74 g for the handled group and 44.34 g for the nonhandled group. This difference was significant beyond the 0.05 level. The mean weight for the groups at 70 days was 248.78 g for the handled group and 230.28 g for the nonhandled group. This difference was significant beyond the 0.01 level. These results are consistent with those previously reported (*5*) under identical conditions.

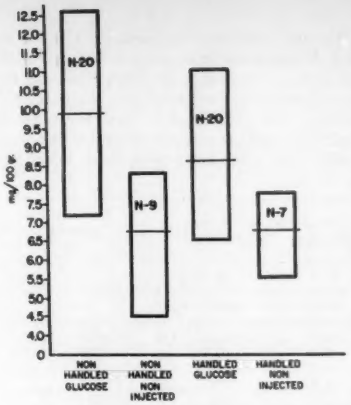


Fig. 1. Comparison of weights of adrenals of the various groups. The lengths of the bars indicate the range of individual values; the light lines, the means; and the numbers, the subjects within each group.

Although there was no significant difference in mortality between the groups following the glucose injection (three handled and two nonhandled rats died), there was a significant difference at the 0.02 level in the adrenal weights following the glucose injection. The adrenal weights for all the groups are presented in Fig. 1. It is important to note that, although the weights of the adrenals of the nonhandled animals were greater than the weights of those of the handled, both groups receiving the glucose injection had significantly greater adrenal weights than had their nonstressed controls. The noninjected groups had almost identical mean adrenal weights. Finally, the handled group consumed 4.29 g of water following glucose injection, whereas the nonhandled group consumed 2.11 g. This difference is significant beyond the 0.01 level. The difference between the handling procedure used in this experiment and the gentling procedure used by Wieninger should be recognized. Whereas Wieninger stroked and fondled his rats, the rats in this study were merely transported from the nest to a compartment and after 3 minutes were returned to the cage. That this procedure produces results similar, if not more profound, than those produced by the gentling procedure argues against the concept of "gentling" and the surplus meaning associated with this term as the major variable in the effects of early experience on behavior under stress in adulthood. It has been proposed (*6*) that handling constitutes a stressful situation for the infant organism and that early experience with stress results in a greater ability of the organism to adapt to psychological and physiological stress in adulthood.

Bovard (*7*) has suggested that, as a result of early handling, the threshold for emotional reactivity is raised. The present data suggest a more generalized hypothesis—namely, that the nonhandled animals are more profoundly affected by stress, both psychological and physiological. The greater adrenal weights of the nonhandled animals following glucose injection suggests a greater output of ACTH as a result of stress. The differences in the water intake may be a result of greater ADH production by the nonhandled rats following stress. Insofar as both ACTH (*8*) and ADH (*9*) have been shown to increase markedly following noxious stimulation, the hypothesis that handling in infancy reduces the physiological response to stress is supported.

Since ACTH (*10*) and ADH (*11*), and in general the stress reaction (*12*), appear to be mediated through the central nervous system, it is my belief that the effects of early experience modify later reactivity of the central nervous system under stress conditions. The precise nature of this modification is still unknown.

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28 May 1957

## Inapparent Lymphocytic Choriomeningitis Infection in Folic Acid-Deficient Mice

Administration of amethopterin, or maintenance on folic acid-deficient diets, frequently causes mice to survive usually fatal lymphocytic choriomeningitis (LCM) infections, the virus being recoverable for long periods (*1, 2*). The experiments reported in this article deal with persistence of virus in treated mice having mild or inapparent infections.

Male mice from NIH stock were used, either Swiss "general purpose" or strain C57B1. The former, weighing 16 to 18 g when inoculated, were given bread-and-milk diets; the latter, weighing 7 to 9 g,

Table 1. Influence of amethopterin and of folic acid deficiency on inapparent LCM infection in mice. Data were compiled from four independent experiments. Virus was injected subcutaneously (s.c.) or intraperitoneally (i.p.) (column 2). Diet C2F was deficient in folic acid and contained 0.5 percent DL-methionine in addition to the published ingredients (*3*); the mean weight of these mice was 15 g. Diet C2 was the same as diet C2F, except that it contained 3 mg/kg of folic acid; the mean weight of the mice was 26 g. The mice in groups E and F were C57; the other mice were Swiss, which received bread-and-milk diets (*2*).

| Group | Injection | Treatment or diet | Virus recoveries/No. of trials at postinoculation intervals | | | | | | Last recovery (last test) (day) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | < 10 days | | 10 to 20 days | | > 20 days | | Blood | Pool* |
| | | | Blood | Pool* | Blood | Pool* | Blood | Pool* | | |
| A | s.c. | Amethopterin | 4/6 | 3/3 | 4/4 | 2/2 | 3/7 | 4/5 | 24(38) | 28(38) |
| B | s.c. | No treatment | 1/6 | 2/3 | 0/4 | 0/2 | 0/7 | 0/5 | 6(38) | 6(38) |
| C | i.p. | Amethopterin | 6/6 | 3/3 | 3/5 | 3/3 | 6/7 | 5/6 | 50(50) | 35(35) |
| D | i.p. | No treatment | 3/6 | 3/3 | 0/5 | 1/3 | 0/6 | 0/6 | 6(36) | 17(35) |
| E | s.c. | Diet C2F | 2/6 | | 1/1 | | 3/3 | | 36(36) | |
| F | s.c. | Diet C2 | 1/2 | | 0/1 | | 0/4 | | 9(36) | |

* Pool of liver, spleen, and kidney.

were given synthetic diets (*3*) starting 6 weeks before inoculation. One basal synthetic diet, designated C2F, was deficient in folic acid; the other, designated C2, contained 3 mg of folic acid (pteroylglutamic acid) per kilogram. Lymphocytic choriomeningitis virus was an intracerebrally passaged strain (*3*), given subcutaneously or intraperitoneally as infected brain emulsion, 0.15 ml of $10^{-3}$ dilution, or intracerebrally in 0.03-ml doses of $10^{-5}$ dilution. Viremia was detected by intracerebral injection of heart blood diluted 1/10; five mice were used for each test. For virus demonstration in other tissues, the dilution was $10^{-3}$, given intracerebrally to each of five mice; emulsions were made by hand grinding in mortars; dilutions were made with buffered saline. Amethopterin, 0.3 mg/ml in 2-percent $NaHCO_3$, was given intraperitoneally on the third, fifth, seventh, and ninth days after virus injection.

In four experiments, inapparent infection was produced by giving LCM virus subcutaneously or intraperitoneally (*4*). Data are presented in Table 1. Virus was not recovered from control, nondeficient mice after the ninth day, with a single exception on the seventeenth. In amethopterin-treated mice, and in those on folic acid-deficient diet, virus was regularly demonstrated for 4 weeks or longer.

In another experiment, mice given LCM virus subcutaneously were challenged 2 weeks later (after immunity had developed) by homologous virus inoculated intracerebrally; some were treated with amethopterin, and others were left untreated. No virus was recovered from blood or brains of mice in either group in eight attempts between the sixth and fifteenth days after intracerebral challenge; in parallel tests on nonimmune mice, virus was recovered from treated mice as reported previously (*2*).

The significant effect common to these and previous (*1, 2*) experiments is the prolongation of infection by interference with folic acid activity. The contrast between this persistent infection and the normally self-limited one is illustrated by the following fortuitous observation. Two C57 mice of a group of five on a nondeficient diet (*5*) happened to survive an intracerebral injection of virus, although they became extremely ill. After their recovery, attempts to demonstrate viremia on the seventeenth and twenty-fourth postinoculation days were unsuccessful. Two other groups of C57 mice (four in one, five in the other) maintained on a folic acid-deficient diet (*5*) had viremia on each of these days, although none had appeared ill at any time.

One interpretation of these results is that mice with defective folic acid activity fail to develop immunity in the normal manner. Consequently, termination of virus replication is delayed. (As is indicated in a preceding paragraph, when immunity was well established before folic acid metabolism was disturbed, virus replication was not detectable.) In the inapparent infections reported here, there is a basic alteration of the mouse's reaction to initial contact with LCM virus, manifested by the development of a carrier state. In the normally fatal infections reported previously (*1, 2*) the creation of the carrier state was possible because, along with virus persistence, there was sparing of the host. This condition of equilibrium between mouse and LCM virus, with both surviving, is known to occur in two other circumstances—namely, when mice are infected *in utero* (*6*), and when they are exposed to x-rays before injection of virus (*7*).

At some stage in the evolving LCM infection in the mouse, there appear to be potentialities for different pathways. One leads to rapid virus replication and death of the mouse, another to host immunity and virus suppression, and a third to an intermediate situation characterized by survival of mouse and virus. Folic acid is one factor, although not the only one, in determining which route the infection will take.

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25 February 1957

# Book Reviews

**The American Oasis.** The land and its uses. Edward Higbee. Knopf, New York, 1957. iv + 262 pp. + index. Illus. $5.

Edward Higbee gives us a very workmanlike, accurate, and well-composed book on American land use. The oasis (actual and potential) to which he refers in his article is the United States itself. A professional agronomist with practical experience in the Soil Conservation Service and now a member of the faculty of Clark University, he has traveled widely over the nation to prepare for writing his book and knows at first hand whereof he writes. While his present position enables him to speak with greater freedom than the civil servant usually has, he certainly respects the discipline of the trained scientific observer.

Three brief and lucid chapters on man, climate, and soil lay the groundwork for the ecological analysis that follows. Six regions—the arid lands, West Coast, the Plains, corn belt, East Coast (the old frontier), and the South (the new frontier)—are then discussed, while a final chapter of forecast concludes the work.

It happens that I have, within the past 15 months, been in each of these regions and have enjoyed excellent opportunities to observe land-use patterns and practices. If the author has made any slip in analysis or appraisal, I have failed to catch it. His skill in hitting essentials while recognizing diversities within each region is particularly noteworthy. So, too, is his recognition of the economic and other pressures which, impinging upon the individual and community, lead to practices that favor immediate advantage rather than the long-time national interest. His justification of agricultural subsidies is frank and ingenious, possibly sound, even though not wholly convincing to one who, like myself, has long been skeptical of this device.

Quite properly he points out the very constructive work being done through local cooperation with the technical personnel of the Soil Conservation Service. The potentials and limitations of irrigated land, the great advances in forest management by large corporations, the need for a balance between row crops (especially corn and legume meadows), the major importance of corn and livestock, and the growing importance of capital to the farmer are among the many topics discussed. Of especial interest is his promising forecast for the southern states, blessed as they are with a long growing season and ample moisture.

I hope the book will be widely read, not only by scientists, but by bankers, politicians, and businessmen as well as by the general run of citizens. In it they will find compact and convenient analysis of their own immediate locale as well as good presentation of the national picture.

The author's outlook for the future is one of qualified optimism. He seems resigned, however, to the explosive growth of population and what he very properly describes as the glacial expansion of industry and urban development into rich valley lands. That this, before long, will place a premium on better land-use practices cannot be doubted. The day of vast surpluses, as he points out, is nearing its close.

But I regret the taboo that keeps such a clear-sighted analyst from at least suggesting that, along with improving the productivity of our land, we ought to face squarely the problem of our own increase in numbers and massive urbanization. Shall science and technology be strained to the utmost merely to serve the needs of an unbridled reproduction and an ever-increasing drain upon resources? Or does human dignity and the quality of human living require an even broader approach to the problems of our future?

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**Methods of Biochemical Analysis.** vol. 4. David Glick, Ed. Interscience, New York, 1957. ix + 362 pp. Illus. $8.50.

The objectives of this series are to review recently developed or improved methods used in biochemistry, to critically evaluate them, and to present the best methods available in enough detail to enable the individual to carry out the analyses. The authors represented in this volume have done commendable work in carrying out these objectives. In general, the discussion of the methods is clear and concise, and the recommended analytic procedures are very well presented.

The first half of this volume is devoted to the methods available for the analysis of a number of lipoid substances. These include bioassay techniques for vitamin A, spectrophotometric methods for carotene, alkaline isomerization methods for polyunsaturated fatty acids, and the phenylhydrazine-sulfuric acid method for 17,21-dihydroxy-20-ketosteroids.

The rest of the book is devoted to an excellent review on the application of the *p*H-stat to biochemical problems, the assay of a number of sulfatases, the determination of serum acid phosphatases in which the Fishman-Lerner method is described, the determination of succinic dehydrogenase activity with emphasis on the phenazine methosulfate method for the primary dehydrogenase, and the determination of amino acids by the use of bacterial amino acid decarboxylases.

In general, this volume maintains the high standards set by the other volumes of this series. It should be of great value as a reference book for biochemists who are interested in the subjects that are discussed.

JAMES R. GILLETTE
*National Heart Institute, National Institutes of Health*

**The Scientific Thought of Henry Adams.** Henry Wasser. Henry Wasser, University of Salonika, Greece, 1956. 127 pp. $5.50.

Henry Wasser's monograph ably demonstrates that Henry Adams had an active and well-informed interest in the many scientific controversies and philosophies that flourished in his day, and that, throughout his literary career, his urge to assimilate the best scientific thought of his time in arriving at his own views of human life and society left its impress on his autobiographical, historical, and philosophic works.

Both in *The Education of Henry Adams* and in *Mont-Saint-Michel and Chartres*—the books which record, as it were, the intellectual autobiography of Henry Adams—he is revealed endeavoring to express his concepts in terms made familiar by scientists, such as Darwin, Wallace, Huxley, and Lyell, engaged in the debate over the ideas of biologic and geologic evolution. In dealing with the persistent philosophic problems of unity versus multiplicity, Adams earnestly sought to reconcile the concepts of theology and religion with those of exact science. Later, after the work of Clerk Maxwell, Gibbs, and Heisenberg, Adams optimistically hoped that the

second law of thermodynamics would lead to a principle that would explain phenomena in human beings and in human society that had hitherto not been amenable to explanation by any accepted "scientific law."

Wasser emphasizes in his introduction (page 5): "Adams was a man of letters who dealt with science on its own terms. Since he was not sufficiently equipped to make original contributions, his science would not interest the professional scientist. It would interest the layman who enjoys Adams. Science by its determinism gave pattern to *The Education of Henry Adams* and *Mont-Saint-Michel and Chartres,* by its content furnished ideas for his letters and essays, and by its generalizations lent a theory to his works on history. In short, all these works which make Adams the keenly interesting figure that he is owe much to his studies in science. Because Adams did meet science on its own terms and not by means of some other discipline, he can be thought of as a lay philosopher of science. Science for science's own sake is a crucial element in the *Weltanschauung* of his prose."

This paragraph sums up the peculiar interest that the thought of Henry Adams has for the active scientist and is the main theme running through Wasser's informative account of Adams, the man of letters with an abiding special interest in science.

FRANCIS R. JOHNSON
*Stanford University*

**Handbuch der Physik.** vol. 48, *Geophysics II.* S. Flügge, Ed. Springer, Berlin, ed. 8, 1957. 1045 pp. DM. 198.

Volume 47 (*Geophysics I*) of this *Handbook* is entirely devoted to physics of the solid earth [*Science* **124**, 829 (1956)]; the present volume 48 contains mainly chapters dealing with physics of the atmosphere and of the ocean, while general aeronomy, physics of the ionosphere, and terrestrial magnetism are to be included in volume 49. In the previous edition of the *Handbook,* most of the topics covered in volume 48 had not even been mentioned. To do justice to the great amount of information now included, a review covering several pages would be required.

Volume 48 begins with a chapter by A. Eliassen and E. Kleinschmidt, Jr., "Dynamic meteorology," which includes basic theory, waves in the atmosphere, large-scale motions, cyclones, and the general circulation in the atmosphere (145 pages). The following four chapters cover radiation and optics of the atmosphere: F. Möller, "Radiation in the lower atmosphere," from sun, sky, and the ground, absorption, and the radiation balance (in German, 108 pages); W. E. K. Middleton, "Vision through the atmosphere," extinction of light, visibility, colors, and pertinent instrumentation (34 pages); Z. Sekera, "Polarization of skylight," including theory, observations, and neutral points (41 pages); and J. Bricard, "Diffusion by rain drops," covering theory, rainbows, diffusion in clouds, rain, and fog (in French, 41 pages).

The late E. Regener had contributed to the first draft of the chapter, "Ozone in the atmosphere," in which H. K. Paetzold discusses the ozone spectrum, methods to measure the amount of ozone in the atmosphere, theory of its formation and destruction, and its distribution and effects, especially on the stratosphere temperature (in German, 57 pages). "Geophysical aspects of meteors," by A. C. B. Lovell, contains data on meteor heights and on winds in the upper atmosphere (28 pages). This is followed by E. F. Cox's "Sound propagation in air," including theory, recording of sound, effects of wind, and natural oscillations of the atmosphere (24 pages).

The last two chapters on the atmosphere are by F. H. Ludlam and B. J. Mason, "The physics of clouds," their forms, condensation and nuclei, droplets, formation and growth of crystals and of precipitation, and cloud seeding (62 pages), and by R. Mühleisen, "Atmospheric electricity," its measurement, ions, thunderstorms, currents, and the electric balance (in German, 67 pages).

"Oceanography," by H. U. Sverdrup, is rather condensed, in view of the extensive textbooks on the subject, and includes methods of observation, water masses and their properties, theory, currents and their effects (63 pages). H. U. Roll discusses "Surface waves of the ocean," their theory, recording and observations of waves and swell in the open ocean and near the coast (62 pages).

The following four chapters give an excellent account of all kinds of tides: J. Bartels, "Tidal forces," theory and extensive numerical data on important Fourier terms produced by sun and moon (in German, 31 pages); R. Tomaschek, "Tides of the solid earth," theory (including effects of the earth's structure), recording and results, effects of meteorological phenomena, of oceans, and of local geology (71 pages); A. Defant, "Tidal waves and tides in water," their theory, standing and internal waves, special harmonics of ocean tides, separation from effects of body tides, tidal friction (in German, 82 pages); W. Kertz, "Atmospheric tides," their theory under various assumptions, observations, and free vibrations of the atmosphere (see also the chapter by Cox) (in German, 53 pages).

Finally, S. Sakuma and T. Nagata, in "Physical volcanology," summarize information on volcanic earthquakes, magnetic phenomena near volcanoes, data on volcanic energy, and on magma (30 pages). This is followed by one subject index in German-English and one in English-German (33 pages).

Most of the sections and the printing and illustrations are excellent. Several chapters offer the first modern comprehensive presentation of their subjects. For many purposes, combined use of all three volumes is desirable; for example, volume 48 does not contain data, except incidentally, on composition, diffusion, temperature, pressure, or density in the atmosphere; these will probably be included in volume 49. The space devoted to the major topics is rather uneven—for example, 255 pages of volume 48 for the various types of tides but only 31 pages of volume 47 for gravity and isostasy. Some such differences are justified by the fact that, for various fields of geophysics, extensive up-to-date textbooks exist, but none for others. The two published volumes are worth the rather large expense to anyone who needs, fairly frequently, data concerning geophysical instruments, observations, or theories.

B. GUTENBERG
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**Chemical Engineering Practice.** vol. 3, *Solid Systems.* Herbert W. Cremer, Ed. Academic Press, New York; Butterworths, London, 1957. vi + 534 pages. $17.50 per volume ($13.30 per volume on orders for complete set).

Volumes 1 and 2 of *Chemical Engineering Practice* (there will be 12 volumes in all) were favorably reviewed in the 29 March issue of *Science* [*Science* **125**, 605 (1957)]. Volume 3 continues the comprehensive treatment of the chemical engineering complex and is devoted to a discussion of solids preparation. Again, it is my pleasure to report on the excellent treatment given the subject matter.

The volume is divided into five sections, each with several chapters devoted to different aspects of solids preparation. These sections are "Size reduction," "Screening, grading and classifying," "Mixing of solids," "Storage and handling of solids," and "Cleaning gaseous media." With the exception of the first section, of which three of the five chapters are contributed by Harold Heywood, the book is almost wholly a compilation of theory and practice by members of the staff of Simon-Carves, Ltd. The editors have done well in organiz-

ing a rather heterogeneous amount of material.

Although much of the volume is devoted to British methods, the principles developed are sufficiently general to be of universal applicability. The volume fills a need among both chemical and mining engineers.

J. M. DallaValle
*Georgia Institute of Technology*

**The People of Puerto Rico.** A study in social anthropology. Julian H. Steward, Robert A. Manners, Eric R. Wolf, Elena P. Seda, Sidney W. Mintz, and Raymond L. Scheele. A Social Science Research Center Study, College of Social Sciences, University of Puerto Rico. University of Illinois Press, Urbana, 1956. 540 pp. Illus. $10.

*The People of Puerto Rico* is an important book, not only for all those who are interested in Puerto Rico, the islands of the Caribbean, and Latin-American cultures, but also for all social anthropologists and sociologists who are interested in the analysis of complex contemporary cultures and societies. It provides useful and important empirical data on the society and the culture of Puerto Rico. But even more important is its theoretical contribution with respect to the use of the "community study" method for an understanding of national (in this case insular) cultures. Several decades ago, social anthropologists turned from the study of homogenous primitive cultures to communities within the context of great civilizations and nations. Such studies have been undertaken of communities within many modern nations—in Ireland, France, Mexico, Brazil, China, and the United States, to mention but a few. These studies have contributed much to the understanding of the national cultures of the nations concerned. Yet, studies of individual communities, many of them small rural communities, provide a picture of only one small segment of a complex modern society. Often such community studies have not shown the relationship of the single community to the nation; they have tended to treat the community as if it were an exotic and isolated tribe. The present book by Julian Steward and his associates offers a conceptual scheme for integrating studies of individual communities into a national (insular) frame of reference, and the authors have applied that scheme admirably for Puerto Rico.

Concretely, this team from Columbia University undertook studies of four Puerto Rican communities as well as another study—for which they used social anthropological techniques—of the prominent upper-class families who resided in the city of San Juan. Each of these communities was selected to represent an important variant of Puerto Rican culture—or, in other words, a "subculture." Thus, a community that produces tobacco and mixed crops, located in the central mountain region, was studied by Robert Manners; a community that produces coffee, located in the western highlands, was studied by Eric Wolf; a community of workers on a large government-owned sugar plantation was studied by Elena Padilla Seda; and a community of workers on a large corporation-owned sugar plantation was studied by Sidney Mintz. Raymond Scheele carried out the study of the urban, upper-class subculture. These individual studies were closely coordinated; they cover much of the same ground and deal with a comparatively large number of island-wide problems. They are brought into relationship with one another and with Puerto Rican insular institutions by a careful perusal of the historical background and by an excellent comparative analysis of the regularities and variants that appear in the various Puerto Rican subcultures that are covered by the study. Thus, each community is seen not as an isolated and local manifestation of a complex society but in relationship to the whole culture.

This study is a model, so to speak, of group research in social anthropology. There will be social scientists who will argue with some of the theoretical concepts, but all will recognize that this book by Steward and his associates is a major step forward in the adaptation of the methods and theories of social anthropology to national cultures. It may well become a modern classic in social anthropology, comparable in importance, in its time, to Robert Redfield's *The Folk Culture of Yucatan.*

Charles Wagley
*Columbia University*

**Marine Algae of the Northeastern Coast of North America.** William Randolph Taylor. University of Michigan Press, Ann Arbor, rev. ed., 1957. viii + 509 pp. Illus. $12.50.

For the past 20 years William Randolph Taylor's *Marine Algae of the Northeast Coast of North America* has been a standard treatise on marine algae. The revised edition follows the same format as the first, both with respect to keys and descriptions of orders, families, genera, and species. For each species the description is followed by notes on distribution within the range covered by the book, and by bibliographic references. The new edition contains descriptions of three genera and 14 species not known for the area at the time of the first edition. In addition, information concerning the range of many species is amplified, especially that for arctic species found in the northern portion of the area covered by the book.

Critical studies on type specimens by the author and by other phycologists has necessitated change in certain specific names appearing in the first edition. More modern views concerning relationships of certain families have been followed, and this has resulted in transfers from one order to another.

The revised edition, similar to the first, is not a compilation but is based in large part on study of living and herbarium specimens. Records from the area, given by other phycologists, have been scrutinized with care, and wherever possible herbarium specimens authenticating these records have been studied. The result is a book of the same scholarly quality as the first edition.

Gilbert M. Smith
*Stanford University*

**Vergleichende Physiologie.** vol. III, *Ernährung, Wasserhaushalt und Mineralhaushalt der Tiere.* W. von Buddenbrock. Birkhäuser, Basel, Switzerland, 1956. 677 pp. Illus. DM. 66.

This is the third in a series of volumes of W. von Buddenbrock's *Vergleichende Physiologie.* The first volume dealt with sense physiology, the second, with nerve physiology and hormones. The first 424 pages of this volume deal with nutrition, feeding, and digestion; the next 127 pages, with water balance (osmoregulation); and the final 67 pages, with mineral economy. Each of the first two sections opens with an extended discussion of the general physiology of the subject. Then follows an account of the function in each principal group of animals, from protozoans through vertebrates. The work is designed for zoologists, and the general physiological discussions do not include many physicochemical details of cell physiology.

Vitamins are treated briefly in the general section, scarcely at all for specific animal groups. Feeding mechanisms and the morphology of digestive systems are well presented, with useful diagrams. Many tables summarize the distribution of digestive enzymes in different animals. Characterization of proteases is by *p*H optima rather than by specific substrates; lipases and esterases are not clearly distinguished. Controversial matters, such as the importance of dissolved organic foods and the relative roles of extracellular and intracellular digestion in pelecypods, are critically examined.

The chapter on vertebrate digestion includes a discussion of the functions of the liver.

The section on water balance is a useful factual account. The ecological applications of osmoregulation are mentioned briefly for each major animal group. Under mineral metabolism are considered the principal inorganic cations and some of the trace elements. The principal functions of each of these are listed, and tables of ion concentrations in various tissues and body fluids in various kinds of animals are given. Some important functions are omitted—for example, the role of cobalt in vitamin $B_{12}$. Active transport of ions as a factor in regulation is mentioned only briefly.

This book, together with the other volumes comprising the total work, will stand as the classical summary of comparative physiology prior to about 1950. Reviewers of modern literature can refer with confidence to von Buddenbrock for the older material. The text is written in a clear, concise style that can be read by a student who has only moderate facility with German. The book provides a good background for a student entering the field of comparative physiology, and it serves as a reference source for zoologists who seek leads to specific older papers. The literature of physiology is becoming so vast that it is doubtful that one man will ever again be able to write such a broad, multivolume work, and the subject is changing so rapidly that monographs are now replacing the handbooks of past generations. It is fortunate that von Buddenbrock's vast knowledge can be recorded, and his remaining volumes are awaited with interest.

C. Ladd Prosser

*University of Illinois*

**Matrix Calculus.** E. Bodewig. North-Holland, Amsterdam; Interscience, New York, 1956. 334 pp. $7.50.

One reads *Matrix Calculus* with alternating feelings of exasperation and admiration. The book is concerned primarily with the computational aspects of the subject, yet, on page 1, a scalar product of two simple numerical vectors is incorrectly given. This is a simple proofreading error, of course, but hardly an auspicious beginning. Perhaps it will serve to warn the reader to be on his guard in the succeeding pages.

During 1947 and 1948, E. Bodewig published, in the *Proceedings of the Royal Academy of Science, Amsterdam,* a series of papers in which he summarized known methods of inverting matrices and solving systems of equations, comparing them with respect to operational counts and other considerations. This material is reworked and brought up to date in the present volume. Curiously, though, no reference is made to Forsythe's summary, which appeared in 1953 in the *Bulletin of the American Mathematical Society.*

In 1949 and 1950 the author published an analogous summary of methods of obtaining proper values and vectors, this time in the *Atti Seminario Matematico e Fisico dell' Universita di Modena.* It is well worth while to have all this material gathered into a single volume, and those who are interested in computing will find *Matrix Calculus* a useful and stimulating reference book. Nothing else comparable to the Modena papers has been published on the proper value problem.

Presentation of this material is preceded by an introductory section that is intended to supply the required background in matrix theory. Also, this section advocates the use of a system of notation which aims, in particular, at exploiting matrix symbolism to the full and at avoiding, wherever possible, the exhibition of specific elements or coordinates. With this thesis I am in wholehearted agreement. There is no space here to illustrate, but often much can be gained in simplicity and elegance. Unfortunately, the author does not always have the courage of his convictions, and, furthermore, he sometimes introduces irrelevant complexities. Thus, in order to exploit the differential of a matrix, he devotes nearly the whole of page 30 to deriving the standard binomial expansion for $(E+Q)^{-1}$ where $E$ is the identity. This is the essential, although not the stated, content of equations 3.19. Here and elsewhere the differential is only confusing.

On page 32 and the following pages there is a painful derivation, with applications, of a formula for inverting a modified matrix. No reference is made to Woodbury, who proved the formula in its complete generality, although Sherman, Morrison, and Bartlett are mentioned for having given special cases. The author considers only the formula for $(A+B)^{-1}$ where $A^{-1}$ is given and $B$ has rank 1. He does not seem to know that the formula can be generalized to the case of $B$ having rank $r$, which is Woodbury's formula.

It is perhaps not fair to criticize a book for what it does not contain. Nevertheless, *Matrix Calculus* is evidence of a considerable degree of erudition on the part of the author—repeatedly one sees an attempt to trace a method to its source and there are historical remarks, such as those on page 127, about the systems that arise in geodesic surveys—and it seems fair to expect some uniformity in depth. But the uniformity is not there.

To give some other examples: On page 144 is summarized a discussion of convergence of iterative methods of the single-step ("Seidel") and of the total-step types. The author calls those types II and I, respectively. He states Reich's theorem by saying, "For a real symmetrical $A$, Seidel's process converges if, and only if, $A$ is definite." Actually, the theorem states, "For a real symmetrical nonsingular $A$ with positive diagonal, Seidel's process converges if, and only if, $A$ is definite."

A few lines below it is stated as a theorem that "For definite matrices, iteration $I$ may diverge." This should hardly be dignified with the label "theorem." In fact, the author has all the information necessary to establish the very simple necessary and sufficient condition for convergence of iteration $I$ when the matrix is symmetrical with positive diagonal.

In short, the book should be on the shelf of every numerical analyst, but let him read with caution!

A. S. Householder

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**Nuclear Power Engineering.** Henry C. Schwenk and Robert H. Shannon. McGraw-Hill, New York, 1957. xvi + 319 pp. Illus. $6.50.

*Nuclear Power Engineering* is a well-written book, obviously intended for the practical man. It is based on articles which appeared serially in the magazine *Power* over the past several years. A college-level knowledge of mathematics, chemistry, or physics is not a prerequisite for an understanding of the material presented. The book, as such, should have a rather limited appeal for anyone having a direct interest in the science or engineering of nuclear reactors for power. It should have an appeal for those whose interests are more peripheral or are in power engineering as derived from nuclear sources.

The introductory chapters cover, in simple, straightforward language, the general subjects of atomic particles, radioactivity, conversion of mass to energy, nuclear reactors, the behavior of neutrons and neutron fission, and the control of chain reactions. Later chapters cover descriptions of nuclear reactors, reactor materials and systems, and reactor design problems. Other chapters describe each of the reactors now being constructed as part of the Atomic Energy Commission's 5-year reactor development program. A useful 18-page glossary of terms used in the nuclear power field is appended.

C. E. Winters

*Oak Ridge National Laboratory*

## Books Reviewed in The Scientific Monthly, September

*Physics for Everybody,* G. Beiser and A. Beiser (Dutton). Reviewed by H. Laster.

*Introducing Astronomy,* J. B. Sidgwick (Macmillan). Reviewed by W. A. Calder.

*Medicine in a Changing Society,* I. Galdston, Ed. (International Universities Press). Reviewed by R. B. Howard.

*The Classification of Lower Organisms,* H. F. Copeland (Pacific Books). Reviewed by L. H. Hyman.

*Sedimentary Rocks,* F. J. Pettijohn (Harper). Reviewed by P. D. Trask.

*Christian Theology and Natural Science,* E. L. Mascall (Ronald). Reviewed by P. H. Phenix.

*Disaster,* M. Wolfenstein (Free Press; Falcon's Wing Press). Reviewed by D. W. Chapman.

*Milton and Science,* K. Svendsen (Harvard Univ. Press). Reviewed by F. R. Johnson.

*America's Natural Resources,* C. H. Callison, Ed. (Ronald). Reviewed by K. W. Hunt.

*Seitaro Tsuboi Commemorative Volume* (Geological Institute, Tokyo University). Reviewed by R. L. Smith.

*Elements of Engineering Thermodynamics,* R. H. Sabersky (McGraw-Hill). Reviewed by N. A. Hall.

*Comfort for Survival,* A. M. Woodbury (Vantage). Reviewed by L. C. Cole.

*A Textbook of Sound,* A. B. Wood (Macmillan). Reviewed by W. P. Mason.

*Human and Animal Ecology,* vol. VIII of *Arid Zone Research* (UNESCO). Reviewed by P. B. Sears.

## New Books

*Bibliography and Index of Geology Exclusive of North America,* vol. 20, *1955.* Marie Siegrist, Mary C. Grier, and others. Geological Society of America, New York, 1957. 784 pp.

*Biochemical Disorders in Human Disease.* R. H. S. Thompson and E. J. King. Academic Press, New York, 1957. 857 pp. $12.60.

*Chemisorption.* Proceedings of a symposium held at the University College of North Staffordshire, Keele, Staffordshire, by the Chemical Society, 16–19 July 1956. W. E. Garner, Ed. Academic Press, New York; Butterworths, London, 1957. 289 pp. $9.

*College Bound.* Planning for college and career. Map and detailed data on 984 accredited colleges and universities. Samuel C. Brownstein. Barron's Educational Series, Great Neck, N. Y., 1957. 221 pp. Paper, $1.98.

*Cultural Foundations of Education.* An interdisciplinary exploration. Theodore Brameld. Harper, New York, 1957. 351 pp. $5.

*Selected Contributions to Psycho-Analysis.* John Rickman. Compiled by W. Clifford M. Scott. Basic Books, New York, 1957. 411 pp. $7.50.

*Some Aspects of the Chemistry and Toxic Action of Organic Compounds Containing Phosphorus and Fluorine.* Bernard C. Saunders. Cambridge University Press, Cambridge, England, 1957. 247 pp. $6.

*Dermatologic Formulary.* From the New York Skin and Cancer Unit, Service of Dermatology. Frances Pascher, Ed. Hoeber-Harper, New York, ed. 2, 1957. 184 pp. $7.50.

*Electrons Go to Work.* J. Gordon Cook. Dial Press, New York, 1957. 192 pp. $3.

*Excited States in Chemistry and Biology.* C. Reid. Academic Press, New York; Butterworths, London, 1957. 224 pp. $7.50.

*Faune de France.* 61. *Hétéroptères Aquatiques.* Raymond Poisson. Lechevalier, Paris, 1957.

*A Frontal Section Anatomy of the Head and Neck.* Otto F. Kampmeier, Arthur R. Cooper, Thomas S. Jones. University of Illinois Press, Urbana, 1957. 12 pp. $15.

*Golgotha and the Church of the Holy Sepulchre.* Studies in Biblical Archaeology No. 6. André Parrot. (translated by Edwin Hudson from *Golgotha et Saint-Sépulcre,* Delachaux et Niestlé, Neuchâtel, 1955. Philosophical Library, New York, 1957. 127 pp. $2.75.

*Guided Weapons.* Eric Burgess. Macmillan, New York, 1957. 255 pp. $5.

*How to Prepare for College Entrance Examinations.* Samuel C. Brownstein and Mitchel Weiner. Stanley H. Kaplan, Ed. Barron's Educational Series, Great Neck, N. Y., rev. ed., 1957. 218 pp. Paper, $1.98.

*Isotopic Tracers in Biology.* An introduction to tracer methodology. Martin D. Kamen. Academic Press, New York, ed. 3, 1957. 486 pp. $9.50.

*Linear Algebra for Undergraduates.* D. C. Murdoch. Wiley, New York; Chapman & Hall, London, 1957. 250 pp. $5.50.

*The Living Rocks.* Andre Maurois, Geoffrey Grigson, Stevan Eelebonovic (translated by Joyce Emerson and Stanley A. Pocock). Philosophical Library, New York, 1957. 94 pp. $6.

*The Mind of the Murderer.* W. Lindesay Neutstatter. Philosophical Library, New York, 1957. 240 pp. $6.

*Mysteries of Science.* A study of the limitations of the scientific method. John Rowland. Philosophical Library, New York, 1957. 223 pp. $6.

*Niels Henrik Abel, Mathematician Extraordinary.* Oystein Ore. University of Minnesota Press, Minneapolis, 1957. 277 pp. $5.75.

*Organic Reactions,* vol. IX, Roger Adams, Ed. Wiley, New York; Chapman & Hall, London, 1957. 475 pp. $12.

*Physics for Science and Engineering.* Robert L. Weber, Marsh W. White, Kenneth V. Manning. McGraw-Hill, New York, 1957. 625 pp. $8.

*Principes de Synthese Organique.* Introduction au mecanisme des reactions. Leon Velluz. Masson, Paris, 1957. 608 pp.

## Miscellaneous Publications

*(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)*

*Research Corporation, 1956 Annual Report.* Research Corp., New York, 1957. 89 pp.

*Bibliographie der Pflanzenschutz-Literatur.* 1946–47. J. Bärner. Biologischen Bundesanstalt fur Land- und Forstwirtschaft, Berlin, 1957. 460 pp.

*A Bibliography of Syntheses with Carbon Isotopes, 1953–54.* UCLA-395. University of California, Los Angeles Campus, School of Medicine, Atomic Energy Project. Compiled by Judd C. Nevenzel, David R. Howton, Richard F. Riley, Gunther Steinberg, School of Medicine, University of California, Los Angeles, 1957 (order from Office of Technical Services, Dept. of Commerce, Washington 25, D.C.). 377 pp. $1.

*Bibliography on Southwestern Asia.* Nos. 1–4, 1953, 1955, 1956, and 1957. Henry Field. University of Miami Press, Coral Gables, Fla. 106 pp.; 126 pp.; 230 pp.; 464 pp.

*Chemistry of Natural Food Flavors.* Jack H. Mitchell, Jr., Norbert J. Leinen, Emil M. Mrak, David Bailey. Quartermaster Research and Engineering Center, Natick, Mass., 1957. 200 pp.

*A Selected Bibliography Concerning Physiological Factors in Aero-Medical Research and Development.* ASTIA Document No. AD126-401. Joan C. Robinette. Wright Air Development Center, Wright-Patterson Air Force Base, Ohio, 1957. 42 pp. *New Tables of Mie Scattering Functions for Spherical Particles.* pt. 2, *Values of Amplitude Functions* $a_m$ *and* $b_m$ *for Refractive Index* $n = 1.40$ *and for Size Parameters* $A = 0(0.1)30$. ASTIA Document No. AD-98768. Geophysical Research Papers No. 45. Rudolf Penndorg and Bernice Goldberg. Geophysics Research Directorate, Air Force Cambridge Research Center, Bedford, Mass., 1957. 235 pp. (Order from Armed Services Technical Information Agency, Document Service Center, Dayton 2, Ohio.)

*Pasteur Institute of Southern India, Coonoor, Annual Report of the Director, 1956.* 27 pp.; *Golden Jubilee Souvenir, 1907–1957.* 150 pp. Pasteur Institute of Southern India, Coonoor, 1957.

*Corrosion and Wear Handbook.* For water-cooled reactors. TID 7006. D. J. DePaul, Ed. U.S. Atomic Energy Commission, Washington, D.C., 1957. 293 pp. $2.25.

*Dairy Engineering Conference, Proceedings of the Fifth Annual National at Michigan State University.* Sponsored by the department of agricultural engineering with the cooperation of the department of dairy and the continuing education service. Michigan State University, East Lansing, 1957. 96 pp. $2.

*Genes in Mammalian Development.* University College, London, inaugural lecture. H. Grunеberg. Lewis, London, 1957. 17 pp. 2s. 6d.

*Le Métabolisme du Fructose.* H. G. Hers. Université Catholique de Louvain and Editions Arscia, Brussels, Belgium, 1957. 200 pp.

# Meetings and Societies

## Archeologic Identification

A committee of the National Research Council has spent 2 years in intermittent discussion of identifications provided to archeologists by specialists in such fields as zoology, botany, geology, physical anthropology, and metallurgy, and especially of the interdisciplinary problems that such collaboration raises. The work of this Committee on Archaeological Identifications, under the chairmanship of J. Charles Kelley (Southern Illinois University), culminated in a general conference, held at the Oriental Institute, University of Chicago, 11–13 Mar. 1957, under the auspices of the National Research Council (Division of Anthropology and Psychology) and of the National Science Foundation.

More than 40 invited participants attended. All were North Americans, but research interests in South America, Europe, and the Middle East were represented by such men as Junius Bird, Irving Rouse, Hallam Movius, Herbert Wright, Sheldon Judson, Robert Braidwood, and Charles Reed. Informal papers were presented by Paul Martin, Bird, Stephen Williams, John Champe, Emil Haury, Rouse, Richard MacNeish, Braidwood, Movius, Rutherford Gettins, Walter Taylor, Clyde Kluckhohn, Erik Reed, Volney Jones, Hugh Cutler, Edward Deevey, Barbara Lawrence, Paul Parmalee, Reed, William Burt, Georg Neumann, Judson, Wright, H. R. Crane, W. C. Root, Frederick Johnson, Harry Shapiro, James Griffin, and Glen Finch. However, substantial unanimity on the central points emerged very quickly, so that later speakers heard their theses anticipated by others and discarded their prepared texts to discuss and largely to eliminate minor disagreements and misunderstandings.

The point on which universal agreement was reached was this: The "identification problem," as such, has no intellectual standing and is not the problem at issue. Instead, it is recognized that when a zoologist identifies a collection of animal bones or a botanist identifies plant remains from an archeologic site, such a specialist is (or should be) just as interested in the ancient environment as is the archeologist. The glacial geologist or geomorphologist is likewise concerned with understanding former environments, and whereas culture has not always and everywhere been a major force shaping environments, the interaction of cultural, geomorphic, and pedologic processes is a legitimate and necessary subject of study by a Pleistocene geologist *as* geologist. New techniques in geochemistry, both isotopic and analytic, are finding increased application in archeology, and geochemists in their turn depend on archeologists for more than purely historical knowledge if basic ideas are to be tested in the geochemistry of soils, lakes, the ocean, and the atmosphere. Hence, when the various specialists come together in the study of archeologic sites, there exist the necessary and sufficient conditions for intellectually satisfying collaboration: each specialist finds reasons within his own discipline for solving problems that arise within the other disciplines.

There was no agreement on the name by which this collaborative study should be called; *paleoecology, historical geography,* and the neologism *archeo-ecology* each had some supporters, and both *archeology* and *ecology* could, in principle, be extended to cover the whole subject. What was clear was that the barriers between parts of the subject are breaking down, that paleoecology has an ever-increasing number of practitioners, and that it not only requires but rewards the services of biological, physical, and social scientists of many kinds.

The excavation of the Mesolithic site of Star Carr in Yorkshire by Grahame Clark and others was instanced several times as a model of successful collaboration. The theme of the conference was epitomized in a remark of Volney Jones: an archeologic site is a unique historical document, not only for the development of culture, but for a segment of the history of the earth; archeologists have no need or desire to reserve these records for themselves, particularly when the culture that is recorded is less impressive or less significant than the noncultural remains. Since this is so, many sites should in principle be excavated by botanists or zoologists, who could send the artifacts to "cultural archeologists" for identification.

Appreciation of these ideas, however, is not yet widespread among all the various fields, and the conference devoted considerable attention to the cross-disciplinary educational problem. The problem varies greatly according to the degree of specialization needed, and according to the degree of historical mindedness that prevails among the specialists. Thus no archeologist should have serious trouble finding a petrographer to distinguish flint from chert; this is the "identification problem" in its crudest and most unidirectional form. Glacial geologists, particularly the generation trained by the late Kirk Bryan, are taking greatly increased interest in collaborative studies with archeologists, and qualified graduate students can be found in many geology departments for summer projects, usually for modest salaries and sometimes simply for expense money (Judson, Wright).

In botany and zoology the difficulty is much greater and reflects the generally low esteem in which taxonomic work has been held in the United States (Cutler, Lawrence). Mere naming is never considered to be rewarding in itself; the taxonomist who regards himself as primarily an evolutionist is not greatly interested in the short time-span that archeology provides, at least in the Americas. The taxonomist who is primarily an ecologist is potentially more useful to the archeologist, but there is a serious shortage of such workers. Most animal ecologists are concerned with pressing problems of applied ecology (fisheries, wildlife management) and have no strong interest in paleoecology, and, in addition, they are mammalogists, ornithologists, or ichthyologists, not general or even vertebrate zoologists. Systematic botanists are similarly overspecialized and occupied in problems of their own. It is understandable that identifications provided by such specialists are given grudgingly and after long delay (Taylor) and that their accuracy varies inversely with the distance (geographic and phylogenetic) between the specimen and the specialty. All the archeologists present emphasized that identifications of this sort, of uneven quality and not backed by ecologic interpretation, are of little if any use to them. Yet, if paleoecology is an exciting and challenging field, as the paleoecologists present agreed, it will attract able and interested workers in due course.

The shortage of paleoecologists can be alleviated to some extent by the training of archeologists themselves. It was pointed out (Deevey) that several European pollen stratigraphers are in fact archeologists, and that a Ph.D. thesis project involving pollen stratigraphy at one or more archeologic sites is neither improper nor inconceivable as professional training for an archeologist. Similarly, vertebrate osteology and ethno-

botany are not so recondite as to be beyond the capabilities of an archeologist. But whereas any one of these specialized forms of archeology could be undertaken as a career, and probably will be in the near future, no digging archeologist can be expected to command more than a fraction of the techniques and special knowledge that are needed for the whole enterprise (Kelley, Johnson).

Although there was some support for the idea of a national research center, staffed by specialists of many sorts and presumably attached to one of the great museums (Shapiro), or for a "clearinghouse" that would organize identifications on a national or international scale (Taylor), the majority of the conferees believed such schemes to be unworkable and undesirable. Paleoecology, like other kinds of ecology, requires exact and comprehensive knowledge of the physiography, climate, and biota of a region. If raccoon bones turn up in a site, for example, it is essential to their interpretation to know whether the nearest raccoon habitat is 2 or 20 miles away (Taylor), and the statement "does not occur in the region today" is meaningful only when it is made by an ecologist who is able to define the region and to infer the reasons for the presence, absence, or relative abundance of particular species. No imaginable corps of specialists could provide such interpretations for all regions of the world, nor do the reference collections that are necessary for identification exist in any museum or group of museums (Lawrence). On a regional scale, however, it is possible for a small museum or a single investigator to acquire adequate reference collections and sufficient ecologic knowledge to deal with relatively large sections of the biota, such as all vertebrates or all angiosperms. Bones of most fishes, reptiles, birds, and mammals can all be identified at the Illinois State Museum (Parmalee), provided that they live or have lived in Illinois.

The encouragement of regional paleoecologic research was therefore regarded as the most important recommendation of the conference. The University of Arizona, with its program of geochronology and dendrochronology, is an example of the regional research institute that deserves assistance. Investigators in other regions also need and deserve support; for example, provision of a research assistant to the Ethnobotanical Laboratory of the University of Michigan not only would permit the staff to work through the backlog of unidentified specimens in less than the estimated 14.8 years but might even allow new projects to be undertaken.

A standing committee of the National Research Council was considered to be the most appropriate agency to further the aims of the conference. Such a committee should consist of not fewer than three, nor more than seven, members, drawn from biological and earth sciences as well as from anthropology. It should therefore be appointed by the president of the National Academy of Sciences, with advice from all the relevant divisions of the National Research Council. Its functions should be to encourage in all possible ways the interdisciplinary approach to the study of man's past environment—for example, by assembling a directory of qualified and interested specialists willing to collaborate with archeologists, by suggesting and advising on proposals for grants-in-aid by fund-granting agencies, and particularly by recommending new appointments and financial support to strengthen the staffs of various regional research centers concerned with archeology ("the study of the old") in all its aspects.

A resolution was drafted by Braidwood, C. Reed, Movius, Clark Howell, Lawrence, and Deevey and presented by Griffin; it called upon the president of the National Academy of Sciences to appoint a standing committee on [name of subject?], to encourage research in this relatively new and exceptionally broad field. On learning from Finch that such a resolution would be proper and reasonable, the conference passed it without dissent.

EDWARD S. DEEVEY
*Osborn Zoological Laboratory, Yale University, New Haven, Connecticut*

## Animal Disease and Human Health

"Animal disease and human health" will be the subject of a joint conference of the New York Academy of Sciences and the Communicable Disease Center in the Hotel Delmonico, New York, 11–13 Sept. The center is a division of the U.S. Public Health Service, with headquarters in Atlanta, Ga.

The conference will provide a 10-year progress report on the zoonoses, animal diseases which are transmissible to man, or diseases caused by animal parasites. Diseases such as psittacosis, brucellosis, cat-scratch fever, rabies, anthrax, and encephalitis will be reviewed.

Other diseases will be discussed from the standpoint of possible relationship to similar conditions in man. An example is pulmonary adenomatosis, which has been decimating sheep flocks in many parts of the world, and has several factors in common with lung cancer in human beings. For further information, communicate with the academy's public-relations counsel, Medical and Pharmaceutical Information Bureau, Inc., 115 E. 69 St., New York, N.Y.

## American Chemical Society

The nature and hazards of radioactive fallout, chemical advances in the study of cancer and heart disease, and important new raw materials for industry will be discussed at the 132nd national meeting of the American Chemical Society in New York, 8–13 Sept. Some 15,000 chemists and chemical engineers from all parts of the United States and several foreign countries will participate in the meeting, at which some 1500 reports will be presented. Chemical contributions in many other fields, such as food, agriculture, fuel, textiles, rubber, plastics, and sanitation, will be described at more than 200 half-day sessions sponsored by the society's 22 scientific and technical divisions.

Roger J. Williams, president of the society and director of the Biochemical Institute of the University of Texas, will give his presidential address, entitled "Fiddlers' dreams," at a general assembly on the evening of 9 Sept. Winners of 16 awards administered by the society, including 13 prizes of $1000 each, will be announced at this time.

The president of the Chemical Society of Japan, Yuzaburo Nagai, is one of the many distinguished scientists who will speak during the week. His topic will be "Chemical marketing and production—a report from Japan."

Cornelius P. Rhoads, director of the Sloan-Kettering Institute for Cancer Research, New York, will discuss "The soluble puzzle of cancer," and Glenn T. Seaborg of the University of California, who won the Nobel prize for his achievements in nuclear chemistry, will describe "The original process for the extraction of plutonium."

Air pollution is among the themes that will receive intensive consideration. Thirty papers on various aspects of this problem will be presented at a 3-day symposium sponsored jointly by the society's Division of Industrial and Engineering Chemistry and the Division of Water, Sewage, and Sanitation Chemistry. A report on "Investigation inhalation hazard from radioactive fallout" will be given at this symposium by William B. Lane of the U.S. Naval Radiological Defense Laboratory, San Francisco.

## Industry-Education Conference

The National Academy of Sciences and Hughes Aircraft Company sponsored a 6-day Southern California Industry-Education Conference at Lake Arrowhead, Calif., 7–13 July. The conference, attended by 100 national and state leaders in science, education, and industry, provided an opportunity to explore ways of developing cooperative

activities for the improvement of secondary-school science and mathematics programs. The conference was held with the cooperation of the University of California, Los Angeles, and the AAAS.

At the close of the meeting, Joseph B. Platt, president of Harvey Mudd College, was named chairman of a Southern California Industry-Education Council that will carry the responsibility of promoting cooperation between industry and education in Southern California during the coming year. The council membership also includes two school superintendents and two representatives of Southern California Industry. A report of the July conference may be obtained from Dr. Randall M. Whaley, National Academy of Sciences–National Research Council, Washington 25, D.C.

## Society Elections

■ Gamma Sigma Delta: pres., Louis M. Thompson, Iowa State College; v. pres., Roy V. Lovvorn, North Carolina State College; sec., John A. Johnson, Kansas State College, Manhattan; treas., Homer J. L'Hote, University of Missouri.

■ American Nuclear Society: pres., L. J. Haworth, Brookhaven National Laboratory; vice pres., T. G. LeClair, Commonwealth Edison Company; treas., M. A. Schultz, Westinghouse Electric Corporation; exec. sec., W. W. Grigorieff, P.O. Box 963, Oak Ridge, Tenn.

■ Royal Society of Canada: pres., T. W. M. Cameron; v. pres., Pierre Daviault; hon. sec., C. P. Stacey; hon. associate sec., Guy Sylvestre; hon. treas., N. E. Gibbons.

## Forthcoming Events

### September

*29–5.* World Medical Assoc., Istanbul, Turkey. (L. H. Bauer, 10 Columbus Circle, New York 19.)

*30–2.* American Oil Chemists' Soc., fall, Cincinnati, Ohio. (Miss L. R. Hawkins, AOCS, 35 E. Wacker Dr., Chicago 1, Ill.)

*30–8.* International Council for the Exploration of the Sea, 45th annual, Bergen, Norway. (A. Fridriksson, ICES, Charlottenlund Slot, Charlottenlund, Denmark.)

### October

*1–4.* American Roentgen Ray Soc., annual, Washington, D.C. (B. R. Young, Germantown Hospital, Philadelphia 44, Pa.)

*2–4.* American Soc. of Photogrammetry, semi-annual, St. Louis, Mo. (C. E. Palmer, ASP, 1515 Massachusetts Ave., NW, Washington 5.)

*2–4.* Antibiotics, 5th annual symp., Washington, D.C. (H. Welch, Div. of Antibiotics, Food and Drug Administration, U.S. Dept. of Health, Education, and Welfare, Washington 25.)

*4.* Role of Agriculture in Future Society, 75th anniversary symp., Geneva, N.Y. (New York State Agricultural Experiment Station, Cornell Univ., Geneva.)

*4–6.* Indiana Geologic Field Conf., 9th, Mitchell, Ind. (H. H. Gray, Indiana Field Conf., Dept. of Conservation, Geological Survey, Bloomington, Ind.)

*6–10.* Electrochemical Soc., fall, Buffalo, N.Y. (H. B. Linford, 1860 Broadway, New York 23.)

*7–9.* National Electronics Conf., Chicago, Ill. (J. S. Powers, NEC, 84 E. Randolph St., Chicago 1.)

*7–11.* American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshman, AIEE, 33 W. 39 St., New York 18.)

*7–11.* Research Contributions to Clinical Practice, New York Acad. of Medicine Postgraduate Week, New York. (Secretary, Postgraduate Week, New York Acad. of Medicine, 2 E. 103 St., New York 29.)

*8–10.* International Assoc. of Milk and Food Sanitarians, annual, Louisville, Ky. (H. H. Wilkowske, Dairy Science Dept., Univ. of Florida, Gainesville.)

*8–10.* Upper Air Conf., American Meteorological Soc., Omaha, Nebr. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

*9–11.* High Vacuum Technology, 4th annual symp., Boston, Mass. (Committee on Vacuum Techniques, P.O. Box 1282, Boston 9.)

*9–11.* Society for Experimental Stress Analysis, fall, San Diego, Calif. (W. M. Murray, SESA, P.O. Box 168, Cambridge 39, Mass.)

*9–12.* Tau Beta Pi Assoc., annual, Madison and Milwaukee, Wis. (R. H. Nagel, Univ. of Tennessee, Knoxville.)

*10–11.* Noise Abatement Symp., 8th annual, Chicago, Ill. (J. J. Kowal, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

*10–13.* Angiology, 3rd internatl. cong., Atlantic City, N.J. (H. Haimovici, 105 E. 90 St., New York 28.)

*11–13.* Iroquois Research, 11th conf., Red House, N.Y. (W. N. Fenton, New York State Museum, Albany 1.)

*12.* Fat and Diabetes Symposium, New York, N.Y. (T. Kingsley, New York Diabetes Assoc., 104 E. 40 St., New York 16.)

*13–18.* American Acad. of Ophthalmology and Otolaryngology, annual, Chicago, Ill. (W. L. Benedict, 100 First Avenue Bldg., Rochester, Minn.)

*14–16.* Association of Official Agricultural Chemists, 71st annual, Washington, D.C. (W. Horwitz, Box 540, Benjamin Franklin Station, Washington 4.)

*14–18.* American College of Surgeons, 43rd annual clinical cong., Atlantic City, N.J. (ACS, 40 E. Erie St., Chicago 11, Ill.)

*14–18.* American Soc. of Civil Engineers, New York, N.Y. (W. H. Wisely, ASCE, 33 W. 39 St., New York 18.)

*14–18.* International Industrial Development Conf., San Francisco, Calif. (E. S. Prentice, Stanford Research Inst., Menlo Park, Calif.)

*16–23.* Enzyme Chemistry, internatl. symp., Tokyo and Kyoto, Japan. (Inter-


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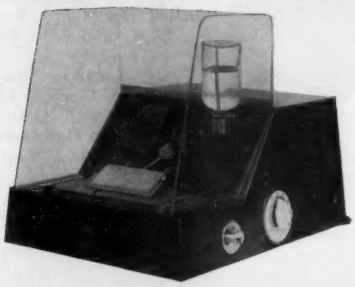

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*17–18.* American Ceramic Soc., 10th Pacific Coast mtg., San Francisco, Calif. (C. E. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio.)

*17–18.* Industrial Hydraulics, natl. conf., Chicago, Ill. (Conference Secretary, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

*17–19.* Indiana Acad. of Science, Greencastle. (H. Crull, Dept. of Mathematics, Butler Univ., Indianapolis 7, Ind.)

*17–19.* Optical Soc. of America, Columbus, Ohio. (S. S. Ballard, Visibility Lab., Scripps Institution of Oceanography, San Diego 52, Calif.)

*18–19.* National Soc. of Professional Engineers, Bismark, N.D. (P. H. Robbins, 2029 K St., NW, Washington 6.)

*19–26.* Social Work, 3rd Pan American cong., San Juan, Puerto Rico. (A. Porrata Dorla, Apartado 3271, San Juan.)

*20–22.* American College of Apothecaries, St. Louis, Mo. (R. E. Abrams, Hamilton Court, Chestnut and 39 St., Philadelphia, Pa.)

*20–27.* International Soc. of Surgery, 17th cong., Mexico, D.F., Mexico. (P. Martin, ISS, 141, rue Bellieard, Brussels, Belgium.)

*21.* Air Pollution Symp., 2nd annual, Philadelphia, Pa. (A. D. Hollingsworth, Franklin Inst., Benjamin Franklin Parkway at 20th, Philadelphia 3.)

*21–25.* Medical Aspects of Workmen's Compensation, New York. (Office of Associate Dean, New York Univ. Post-Graduate Medical School, 550 First Ave., New York 16.)

*21–26.* Ultra High Frequency Circuits and Antennas, internatl. conf., Paris, France. (Congrès Circuits et Antennes Hyperfréquences, Société des Radioélectriciens, 10, Avenue Pierre-Larousse, Malakoff (Seine), France.)

*22.* American Soc. of Safety Engineers, annual, Chicago, Ill. (J. B. Johnson, ASSE, 425 N. Michigan Ave., Chicago 11.)

*22–25.* American Dietetic Assoc., annual, Miami, Fla. (Miss R. M. Yakel, ADA, 620 N. Michigan Ave., Chicago 11, Ill.)

*24–25.* Computer Applications Symp., Chicago, Ill. (Conference Secretary, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

*24–25.* Engineers General Assembly, New York, N.Y. (Engineers Joint Council, 29 W. 39 St., New York 18.)

*24–25.* New Mexico Acad. of Science, annual, Albuquerque. (W. J. Koster, Dept. of Biology, Univ. of New Mexico, Albuquerque.)

*24–26.* Acoustical Soc. of America, Ann Arbor, Mich. (W. Waterfall, ASA, 57 E. 55 St., New York 22.)

*24–27.* American Soc. for Aesthetics, annual, Washington, D.C. (T. Munro, Cleveland Museum of Art, Cleveland 6, Ohio.)

*24–5.* Pan Indian Ocean Science Assoc., 3rd cong., Tananarive, Madagascar. (R. Paulian, Institut de Recherche Scientifique, B.P. 434, Tananarive.)

*25–26.* Kentucky Acad. of Science, Berea. (G. Levey, Berea College, Berea.)

*25–26.* Midwest Conf. on Biology Teaching in Colleges and Smaller Universities, Des Moines, Iowa, (L. P. Johnson, Dept. of Biology, Drake Univ., Des Moines 11.)

*25–28.* American Heart Assoc. Scientific Sessions, Chicago, Ill. (Medical Director, AHA, 44 E. 23 St., New York 10.)

*26.* American Mathematical Soc., Washington, D.C. (J. H. Curtiss, AMS, 190 Hope St., Providence 6, R.I.)

*27–1.* Atom Fair, New York, N.Y. (Atomic Industrial Forum, 3. E. 54 St., New York 22.)

*28–30.* Association of Military Surgeons of the U.S., annual, Washington, D.C. (R. E. Bitner, AMSUS, Suite 718, 1726 Eye St., Washington 6.)

*28–31.* American Nuclear Soc., 2nd winter, New York, N.Y. (J. Burt, J. M. Mathes, Inc., 260 Madison Ave., New York 16.)

*29–31.* Entomological Soc. of Canada, annual, Lethbridge, Alta., Canada. (R. H. Wigmore, Science Service Bldg., Carling Ave., Ottawa 3, Ont.)

*29–3.* Photoperiodism in Plants and Animals, internatl. conf., Gatlinburg, Tenn. (R. Winthrow, Division of Radiation and Organisms, Smithsonian Inst., Washington 25, D.C.)

*(See issue of 16 August for comprehensive list)*


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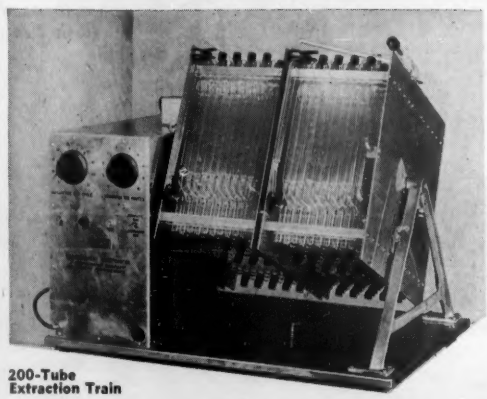

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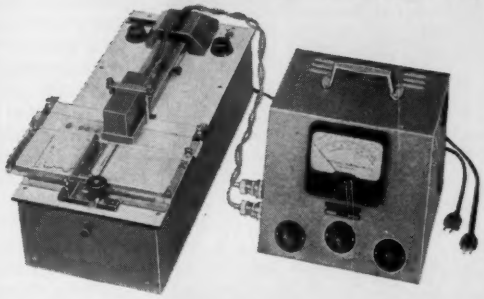

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# EQUIPMENT NEWS

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■ GAMMA REFERENCE STANDARDS are available in the form of $Co^{57}$, $Ba^{133}$, $Cs^{137}$, $Mn^{54}$, $Na^{22}$, and $Co^{60}$ sources. Each source is sealed in a cylindrical Lucite sample holder 5 in. long and ⅝ in. in diameter. The quantity of isotope has been adjusted to yield about 50,000 to 100,000 count/min above 20 kev with activity less than 0.1 μc. (Baird-Atomic Inc., Dept. S513)

■ WIND-RECORDING SYSTEM incorporates a drag-free transducer based on the principle of light-beam chopping. Wind direction is sensed by a low-inertia potentiometer. Accuracy for wind speed is ± 4 percent of full scale and for wind direction, ± 3 percent. Switching is provided among four scales with ranges from 6 to 60 mi/hr. (Beckman and Whitley Inc., Dept. S525)

■ GAS-DENSITY BALANCE measures the buoyancy effect of a gas in producing a rotational moment in a small dumbbell that is supported on a horizontal quartz fiber. The dumbbell is restored to its null position by application of electrostatic force. The magnitude of the balancing potential required is proportional to the density of the sample and is used to operate a meter or recorder. Ranges of 0.05 total span relative to air anywhere from 0 to 5.00 are available. Sensitivity is ± ½ percent of full scale, accuracy ± 1½ percent of full scale. Response of 95 percent is obtained in 1 min. Output is 0 to 5 mv. (Arnold O. Beckman, Inc., Dept. S560)

■ TIME-TO-PULSE-HEIGHT CONVERTER is designed for measurement of time intervals in the range 250 μμsec to 1 μsec. The instrument requires that the time interval of interest be defined by an initial and a final pulse. The output is a pulse whose amplitude is proportional, within ± 1 percent, to the time interval being measured. Readout may be accomplished either by a multichannel pulse-height analyzer or by an oscilloscope. Resolution times of the order of 40 μμsec are said to have been achieved by the instrument. (El Dorado Electronics Co., Dept. S512)

■ PROGRAMMER for six- and eight-channel oscillograph recording systems produces the following automatic sequence for analog computer readout: recorder is turned on; calibration signal voltages are fed to all channels; d-c levels of computer are read; computer output is recorded for predetermined chart length or as controlled by computer; recorder is turned off and programmer is reset. (Sanborn Co., Dept. S502)

■ NUCLEAR-POWERED ELECTRIC TIMER has a shelf and use life of more than 25 years. One model of the timer, 2½ in. in diameter by 1⅞ in. long, provides an electric time delay ranging from several milliseconds to 40 hours with accuracy of ± 3 percent over the temperature range − 65° to 165°F. Time delay may be initiated by snap-action switch, pull wire, or electric signal. Power is furnished by a nuclear battery made in current ratings from 50 to 5000 μμa and equilibrium voltages in the order of 10,000 v. (Universal Winding Co., Dept. S546)

■ INFRARED MONOCHROMATOR is designed to determine the absolute spectral distribution of radiation from airborne targets in the 1.5-to-25-μ region and to determine total radiation. Measurements are recorded on a two-channel recorder. Radiation collected by a Newtonian telescope optical system is reflected alternately to a total radiation detector and a monochromator. Thermistor bolometers are used as detecting elements. (Servo Corporation of America, Dept. S519)

■ ABRASION TESTER combines rotary and reciprocating motions to test the durability of materials that are to be subjected to rubbing and twisting types of wear. Both the reciprocating table and the rotating head to which the sample is attached are equipped with ring clamps, which permit substitutions of a variety of surfaces. Provision is made for wet-and-dry tests. (United States Testing Co., Inc., Dept. S520)

■ MILLIOHMMETER, manufactured by Electronic Instruments Ltd., of England, measures resistance from 20 μohm to 1200 ohm. The instrument is line-operated, using a-c test currents at line frequency. Power dissipated in the test specimen is less than ⅛ w in the worst case. Accuracy is approximately ± 2 percent of full scale. A calibration circuit permits the accuracy to be checked. (Herman U. Sticht Co., Inc., Dept. S526)

■ IONIZATION GAGE measures pressure from $1 \times 10^{-3}$ to $2 \times 10^{-12}$ mm-Hg in eight linear ranges. Tube degassing by both resistance and electron bombardment is provided. Degassing current is


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variable, and pressures can be read continuously while the tube is being degassed. Zero drift of the amplifier is less than 2 percent in 24 hr. (Consolidated Electrodynamics Corporation, Dept. S540)

■ VOLTAGE STANDARD AND NULL METER can be used to provide reference voltages from 1 to 501 v with standard cell accuracy or to measure voltage over the same range. The instrument's chopper-stabilized circuit compares the output with an internal standard cell. As a power supply, the unit will furnish current up to 20 ma. Stability is ± 0.01 percent, accuracy ± 0.02 percent, line and load regulation 0.002 percent, ripple less than 100 μv, response time 0.2 msec, and output impedance less than 0.01 ohm. (Kin Tel, Dept. S542)

■ PORTABLE CARDIOENCEPHALOGRAPH, intended to aid the anesthesiologist during surgery, measures 13 by 13 by 6⅜ in. Chart speeds of 2.5 and 25 mm/sec may be interchanged without shifting gears. Calibration of 100 μv for the electroencephalograph and 1 mv for the electrocardiograph is provided by a Weston cell. The instrument is line-operated and incorporates a regulated power supply. (Gilson Medical Electronics, Dept. S537)

■ TRANSISTORIZED ELECTROMETER has eight ranges from 30 mv to 100 v full scale. Gain is 0.05 to 167. Input impedance is $10^{14}$ ohm. Drift is less than 3 mv/hr after a 1-hour warm-up. Accuracy is within ± 2 percent of full scale. With available accessories, voltages can be measured to 20 kv, currents to $5 \times 10^{-14}$ amp, and resistance to $10^{16}$ ohm. Outputs of ± 5 v and ± 1 ma are provided for recorder operation. (Keithley Instruments, Inc., Dept. S570 )

■ MASS SPECTROMETER operates on the time-of-flight principle of mass separation. Resolving power is sufficient to separate adjacent mass peaks in the 200-atomic-mass unit range. The complete spectrum is analyzed in about 15 μsec and displayed on a cathode-ray oscilloscope. The analysis is repeated at intervals of 500 μsec or less. One fixed setting of the instrument covers the entire mass range. Accessories allow the recording of two individually selected mass peaks and their ratio. Also available are devices for counting of individual ions with digital presentation of ratio in the ion-current range from $10^{-15}$ to less than $10^{-20}$ amp. The instrument is also suitable for molecular beam work. (Bendix Aviation Corp., Dept. S528)

JOSHUA STERN
*National Bureau of Standards*


**The Beginnings of Embryoni Development**

**AAAS Symposium Volume No. 48** **Published July 1957**

**Edited by Albert Tyler, California Institute of Technology**
**R. C. von Borstel, Oak Ridge National Laboratory**
**Charles B. Metz, The Florida State University**

6 x 9 inches, 408 pages, 132 illustrations, references, subject and author index, clothbound

**Price $8.75, AAAS members' prepaid order price $7.50**

A symposium on "Formation and Early Development of the Embryo", held 27 December, 1955, at the Second Atlanta Meeting of the AAAS, served as the basis for this volume. Emphasis was placed on the problems of early development and of the initiation of development. The investigations presented in the various communications cover both descriptive and experimental work on the biological and chemical levels. Apart from their intrinsic interest and the measure of progress that they provide, the specific discoveries and analyses presented serve to exemplify various approaches toward the understanding of the manner in which sperm and egg contrive to produce a new individual.

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**Biochemist;** Ph.D.; 26; teaching and research experience in biochemistry, nutrition, toxicology, isotopes techniques. Desires teaching and/or research position, preferably in nutrition. Sanford A. Miller, Bureau of Biological Research, Rutgers University, New Brunswick, N.J. 8/30

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**Librarian,** woman, 37; master's in technical librarianship; 4 years' experience engineering and science. Reads German, French, Spanish, and Italian; studying Russian. Prefer West or Southwest. Box 250, SCIENCE. X

**Pharmacologist;** 8 years, professor and head, pharmacognosy department, state university; 4 years, director of research, pharmaceutical company. Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

**Physician** with additional training in biochemistry desires full-time salaried position. Experienced in private practice, clinical investigation, and laboratory research; publications; under 40, family; service completed. Box 251, SCIENCE. X

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**Biochemist,** Ph.D.; research on fractionation and chemical studies of mucopolysaccharides and mucoproteins; experience and training in fractionation of high molecular weight compounds; salary $5000–$6000 depending upon qualifications. Apply to Psychosomatic Section, Oklahoma Medical Research Foundation, Oklahoma City 4, Oklahoma. 9/6

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**Director,** diagnostic and research tuberculosis laboratory, central Florida, physician or nonphysician microbiologist or clinical chemist. Part-time employment will be considered. Write Dr. Albert V. Hardy, Director, Bureau of Laboratories, State Board of Health, P.O. Box 210, Jacksonville, Florida. uc

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(a) **Professor or Assistant Professor** in physiology to commence this coming academic year; duties involve teaching, primarily in mammalian physiology and anatomy, and development of research program in field of candidate's choice; not more than 12 contract hours per week of teaching required; new research laboratories; facilities available for research in any area of physiology; coeducational university; resident enrollment 6500. (b) **Biochemist,** Ph.D., for full-time research; experience with blood and tissue homogenate techniques important; research department, national organization; atmosphere similar to that in academic institutions; adequate technical and clerical assistance; medical school city; Midwest. (c) **Clinical Physiologist** experienced in respiratory physiology; preferably physician, Ph.D. eligible; duties: research teaching at graduate and postgraduate levels; university medical school; new teaching hospital; West. (d) **Virologist,** preferably Ph.D.; master's considered; duties consist of conducting survey of research organization; East. S8-5, Medical Bureau, Burneice Larson, Director, 900 North Michigan, Chicago. X

**Research Director** is being sought by a Midwest pharmaceutical firm with 200 employees. Applicant must have Ph.D. Duties involve supervision of basic, clinical, and market research. Box 238, SCIENCE. 8/23, 30; 9/6

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## of the General Program-Directory of the AAAS Indianapolis Meeting by first class mail – early in December

The General Program-Directory of the 124th Meeting of the AAAS in Indianapolis, Dec. 26–30, 1957, will be available to anyone, at cost, within the first week in December—whether he can attend the Meeting or not. You will want the General Program-Directory for your reference shelf.

**Program content**

1. The two-session general symposium, "Moving Frontiers of Science II: Concepts That Mold Our Lives," arranged by the Committee on AAAS Meetings.
2. The six sessions of the Conference on Scientific and Technical Editorial Problems.
3. Programs of the 18 AAAS sections (symposia and contributed papers).
4. Programs of the more than 60 participating societies.
5. The Special Sessions: AAAS, Academy Conference, Conference on Scientific Manpower, National Geographic Society, Phi Beta Kappa, Sigma Xi-RESA.
6. Details of the Murat Temple—center of the Meeting—and of the hotels and other session sites.
7. Titles of the latest foreign and domestic scientific films to be shown in the AAAS Science Theatre.
8. Exhibitors in the 1957 Annual Exposition of Science and Industry and descriptions of their exhibits.

**Directory content**

1. AAAS officers, staff, committees for 1957.
2. Complete roll of AAAS presidents and their fields.
3. The 271 affiliated organizations.
4. Historical sketch and organization of the Association; the Constitution and Bylaws.
5. Publications of the Association.
6. AAAS Awards and Grants—including all past winners.
7. Membership figures by sections.
8. Section committees (Council members) in detail.
9. Local committees.
10. Future Meetings of the AAAS through 1962.
11. New and current activities of the AAAS.

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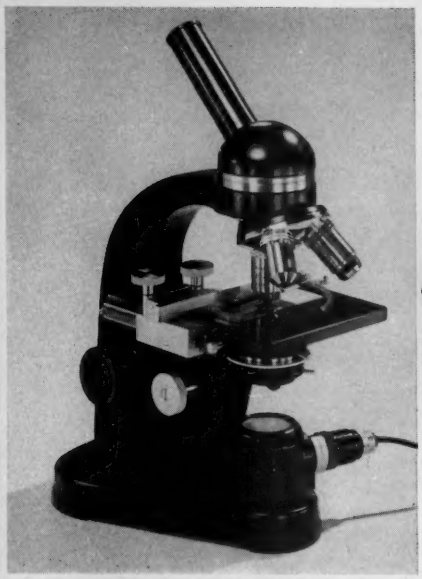

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